A PETROGRAPHIC STUDY OF PRECAMBRIAN ROCKS IN NORTHEASTERN ALBERTA

by

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A THESIS

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The modern method of travel in the north.
(A prospector passing over lake Athabaska).

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CHAPTER I

INTRODUCTION

General Statement

The constantly increasing mineral development in the provinces of Quebec, Ontario and Manitoba of recent years has naturally led to an interest in the possible mineral wealth of the unexplored regions of northern Canada, and directed the attention of the people of Alberta to the possibilities of such wealth in the little corner of the Precambrian shield which lies within the confines of their province.

In response to this interest, the Provincial Government instructed the Research Council of Alberta to undertake preliminary surveys of this little known region of the province. The main object of these surveys was to be an attempt to outline what particular portions of the Precambrian area of northern Alberta would appear to be most worthy of detailed prospecting.

Precambrian rocks underly an area of about 15,000 square miles in the northeast corner of the province. The area is roughly triangular in shape. It is bounded on the west by Slave river and the delta of Athabaska river. South of lake Athabaska the boundary has never been definitely determined, but it is known

to swing in a broad curve to the south and east, cutting the 110th meridian of longitude - the east boundary of the province - at about the 25th base line. The northern and eastern boundaries are the boundaries of the province, the Precambrian area, of course, extending in these directions far beyond the provincial boundaries.

During the field season of 1929 the writer was attached to the first provincial survey party sent into the field. During this season an area of approximately 200 square miles, north of the north shore of lake Athabaska and bordering on the eastern boundary of the province, was examined in some detail, and reconnaissance made of a further area of about 200 square miles adjacent to the east bank of Slave river. Representative suites of specimens of the various rock types occurring in the district were collected. Thin sections of many of these have been prepared. The main purpose of this thesis is to report upon the results of detailed studies of these specimens and thin sections, with a view to determining the various rock types occurring in the area, their mode of occurrence and origin, and any other information that will be of use in further field work.

Previous Work

Geological work in the region north of lake Athabaska has been confined almost entirely to the areas bordering the travelled water routes of the district, namely, the shores of lake Athabaska and the valley of Slave river. The interior country has remained

up until the present, practically an unexplored and unknown region.

In 1888 McConnell[1] examined the south shore of lake Athabaska from Athabaska river to near Point William. He reported the occurrence of thick beds of flat-lying, soft sandstones and conglomerates underlying the greater portions of the country immediately south of Athabaska lake. He named these the Athabaska sandstone, and, on the basis of their stratigraphic position, placed them in the Cambrian.

During 1893, J. B. Tyrrell[2] and D. B. Dowling[2] examined the shores of lake Athabaska between Chipewyan and the east end of the lake, while making a traverse from Athabaska river to the Churchill river. Tyrrell traversed the north shore, while Dowling proceeded along the south shore. The latter found the south shore underlain almost entirely by flat-lying red sandstones and conglomerates, reported by McConnell. Dowling noted that these sandstones were lithologically similar to and had similar intrusive rock associations as those of the Keewenawan of lake Superior, and were therefore placed by him in the Keewenawan.

Tyrrell, following the north shore, reported the occurrence of light reddish, grey, hornblende granites and biotite granites or granitoid gneisses as underlying the greater part of the region. He also reported the occurrence of three small areas of crushed quartzites, red and green schists and associated metamorphic sediments. These he correlated with the Huronian of eastern Canada.

In 1914 Camsell[3] made a reconnaissance journey by canoe from Athabaska lake to Great Slave lake, following the valleys of the Tazin and Taltson rivers, and reported on the general geological features of the country through which he travelled. Although his route lay beyond the boundaries of Alberta, his work is of prime importance in the study of the Precambrian in this province. In this journey he found several fairly extensive areas of early Precambrian sediments, with associated intrusive rocks, to which he gave the name Tazin series, after a lake of that name. Although he did not find evidence of extensive mineralization in these areas, he noted the similarity of conditions with the then developing areas of eastern Canada, and in his report suggested that these were worthy of intensive prospecting. He correlated his Tazin series with the Kewatin of eastern Canada.

In 1914 Haultain and Alcock[4] surveyed and geologically examined the shores of lake Athabaska. Haultain carried out an accurate stadia transit survey of the lake, thus for the first time outlining in detail the shores of this large body of water, although track surveys had previously been made by Dowling and Tyrrell.

During the field season of 1916, Alcock[5] continued the exploratory and geological work begun in the summer of 1914 in the region north of lake Athabaska. As a result of his geological examination of the shores of lake Athabaska, he reported several areas of early Precambrian sediments occurring on the north shore

of the lake. These he later correlated with Camsell's Tazin series. Two of these, of considerable extent, lie east of the east boundary of Alberta, but he also reported one small area within the boundaries of the province. These areas were obviously those that Tyrrell had previously correlated with the Huronian of eastern Canada.

Camsell[6] in 1916 examined Slave river between the mouth of Peace river and Fitzgerald. Although his report on this work was largely on salt and gypsum occurrences in the Palaeozoic sediments, he also makes some mention of the rock types and associations of the Palaeozoic-Precambrian contact as exposed at various places along this portion of Slave river.

Blanchett in 1921 made a trip inland east from Fitzgerald, ascending the Dog river and Leland lakes.

In 1922 Allan and Cameron[7] examined the area immediately adjacent to Moose bay and Old Man river east of Crackingstone point on the north shore of lake Athabaska. Their investigations were confined to the study of certain outcrops of hematite ore occurring in an area of Tazin sediments, and no study was made by them of the general geological features of the region.

During the field season of 1929, useful information was gained on the country east of Fitzgerald by private communication from Messrs. W.G.Jewitt, C.S.Selby, T.Nagel and others of the Consolidated Mining and Smelting Company, who at various times during the past few years have made reconnaissance trips over the major water routes east of Fitzgerald.

CHAPTER II

SUMMARY

Two comparatively small areas in the northeast corner of Alberta were geologically examined during the field season 1929, and representative suites of specimens of the various rock types were collected. Thin sections of 79 of these rocks were obtained. The main purpose of this thesis is to report upon the results of the petrographic studies of these specimens and thin sections. There is, however, included within the thesis a brief discussion of the more interesting geological and physiographical features. No attempt has been made to geologically map the areas in any detail.

Petrographic Features

The rock types studied include grey and red granites and gneisses, with associated basic inclusions, contact phases and metamorphosed sediments.

The granites and gneisses are generally medium to coarsely crystalline, equitextured. The feldspars range from orthoclase to oligoclase. Two feldspars are usually present, one highly altered which is enclosed by a fresher, usually a more acid variety. Green biotite is the usual ferromagnesian mineral present. In practically all cases the granites and gneisses show the results of considerable dynamic metamorphism in the form of strain, crushing and granulation. Color difference

between the red and grey varieties is due to the presence of red iron oxide. A characteristic feature of the feldspar-rich gneisses along Slave river is the presence of fractured, dark red garnet.

Basic inclusions are common to both types of granites. Those associated with red granites have hornblende and pyroxene as the abundant ferromagnesian, while those associated with the grey granite are characterized by the abundance of dark green biotite.

The rocks in the contact zone between the granitic gneisses and the metamorphosed sediments into which they have intruded, show a microporphyritic and microgneissic texture. The porphyritic phase shows abundant phenocrysts, both fresh and altered, of orthoclase and microcline. Ferromagnesian minerals in the form of green and brown biotite, along with chlorite, are abundant.

Metamorphosed sediments include interbedded arkoses, quartzites, slates and schists of the Tazin series, and certain gneiss-like aggregates which occur as small isolated areas in the granitic masses. The Tazin series is, for the most part, feldspathic, with a cementing material of quartz, calcite, micaceous and ferruginous minerals.

Geology

The oldest formation encountered is a biotite augen gneiss. This gneiss outcrops most prominently in the vicinity

of Fishery bay and then elsewhere as small, more localized areas within the later granites and gneisses.

Unconformably overlying this gneiss occurs a well-banded, steeply dipping sedimentary series which Alcock correlated with Camsell's Tazin series of the Tazin lake region. This sedimentary series outcrops most prominently as a fringe along the shore of lake Athabaska extending from a few miles north of Sand point to the vicinity of Fishery bay.

This series was folded and then intruded by granites and gneisses. The granites and gneisses, where in close proximity to the Tazin series, are characterized by a zone of highly contorted, dark green-red flow gneiss. Where assimilation has been most complete, the intruding granite has taken on a red color, due presumably to iron acquired from the intruded sediments. Where the intruding granites and gneisses are further removed from the Tazin they are characteristically of a light pink or grey color.

Unconformably overlying the Tazin series occur two formations. One consists of a somewhat loosely consolidated conglomerate and variegated arkose; the other a silicious red sandstone and conglomerate (Athabaska sandstone and conglomerate).

Along Slave river the Precambrian rocks are overlain by Palaeozoic limestones, dolomites, gypsum and anhydrite.

Throughout the area is scattered the more recent unconsolidated material in the form of lake beaches, sand spits and bars, alluvium, till, relic beaches and boulder pavements.

The intensity of glacial action is manifested in the well developed glacial striae, the rounded roches moutonnees and the innumerable rock basin lakes, both large and small.

Physiography

The physiography of the region is distinctly glacial in character. The lakes where within the more massive rock types, are generally sub-circular in outline, irregularly spaced and disconnected. They are, in many cases, margined with marsh lands, probably spring flood plains. Where the lakes lie in softer rocks of the more schisted zones, they are long and narrow, the long axis conforming with the direction of glaciation or major fracturing of the rock. In these cases the bed rock rises abruptly from the shore, forming steep cliffs. Soil covering, except in the valleys or depressions, is practically absent. In these valleys swamp or muskeg conditions are common.

The drainage connecting the larger bodies of water usually flow underneath glacial boulders or sands. None of the streams are navigable, even by canoe, for any great distance.

CHAPTER III

PHYSIOGRAPHY

Athabaska lake is the chief physiographic feature of the area. This great body of water, 175 miles long by 35 miles wide, has been well described by Alcock[5], who has shown that the general character of the lake is significant of its glacial origin, but it must have been a lake basin of some considerable extent previous to glacial period. Cameron[8] has pointed out that in early post-glacial times Athabaska lake must have had a much greater areal extent than at present, and he outlined various stages of the lake's expansion.

Athabaska river discharges into the west end of Athabaska lake through many channels, forming a delta of considerable extent. Alluvium brought down by this river is rapidly filling in the western end of the lake, and causing a marked turbidity to the waters in this portion of the lake. This turbidity extends at times as far east as Sand point, but east of this the waters rapidly clear.

The waters of lake Athabaska are discharged into Peace and Slave rivers through two main channels, the Quatre Fourches and Rochers rivers. The Quatre Fourches, the more western of the two, flows sluggishly through a broad alluvial plain which is obviously a silted extension of lake Athabaska. The silt is derived in part from Athabaska river, but for the most part from Peace river. The Quatre Fourches is a reversible river; when

the Peace is high some of its waters discharge into lake Athabaska by this channel, although the normal direction of flow is to the north.

The Rochers river forms the main outlet for Athabaska lake and its tributary streams. It flows, for the most part, along the western edge of Precambrian rocks, its eastern bank showing many rocky outcrops while its western bank is mostly silt material.

Between these two rivers (Rochers and Quatre Fourches) lies an area of low relief, composed of silts deposited by Peace river, through which projects hummocks and low rounded rises of Precambrian rocks.

Peace river, flowing from the west, is diverted northward on striking the western edge of the Precambrian shield. At this point of divergence it is joined by Rochers river, and from the confluence flows northward as Slave river, following, as does the Rochers, the western edge of the Precambrian rocks. Throughout its course in Alberta the territory adjacent to its western bank is generally a flat alluvial plain with here and there outcrops of Palaeozoic sediments where the river has cut down to bedrock. The territory adjacent to the east side of the river in a number of places is low and marshy, with numerous open sloughs and old stream courses, the latter being remarkably well shown from the air. The river at high water frequently overflows into these marshy areas so that they are gradually disappearing. As in the country between the Quatre Fourches

and Rochers rivers, hummocks and knolls of Precambrian rocks project through these marshy lands, forming rocky islands, with, however, the main mass of the granitic rocks lying a few miles to the east of the present river.

The region east of Slave river and north of Athabaska lake is practically an unknown country, an uninhabited country and untravelled except by Indians and the occasional white trapper out of Chipewyan or Fitzgerald. These reported the country to be one of a thousand lakes.

In view of the lack of information, the first step was to obtain an accurate detailed map of the district. Therefore the Provincial Government requested the Topographical Surveys Branch of the Department of the Interior, Ottawa, to aerially photograph and map the whole of this region. This work was carried out during 1928 and the first draft of the map of the south half of the area north of lake Athabaska, prepared from these photographs, was available by the beginning of the field season of 1929.

The new map showed that the area, as reported, was indeed one of a thousand lakes. It showed further that the majority of these lakes lie with their long axis in an east-west direction, this direction conforming to the known direction of glaciation in the region. In one portion of the area there is a chain of lakes whose long axis all lie north-south. The southern end of this chain approaches Athabaska lake at the head of a deep bay (Big bay) lying just west of Big (Fidler) point. There is a

distinct difference in the general character of the topography of the country on either side of this chain of lakes. To the west lakes of sub-circular outline form an irregular pattern, with occasionally an elongated lake lying east and west, and this general feature appears to continue south almost to the shore of Athabaska lake. To the east, on the other hand, two features are prominent. Bordering lake Athabaska is a lakeless area about 5 miles wide, apparently formed by a barrier of resistant rock and acting as a watershed of some importance. Inland, north and east, occurs a great series of lakes of considerable size, the shore lines of which have certain distinct characteristics which distinguish them from those of the west. In the first place, the major east-west trend is more prominent; secondly, there is a very definite northwest-southeast trend and a less distinct, but still well evident, third trend northeast-southwest. Although these latter two tendencies are prominent as shoreline characteristics of the larger lakes, they also show in the inter-lake areas as stream courses or minor bodies of water.

The aerial photographs reveal, in a remarkable manner, the general and relative relief of the country. This may be briefly described as the peneplained surface so characteristic of the Precambrian shield. The hills show a rounded character, with only an occasional one rising over 300 feet above the surrounding territory.

CHAPTER IV

GENERAL GEOLOGY

General Statement

The region north of lake Athabaska presents the same denuded appearance that characterizes the Precambrian areas in other parts of Canada. The entire area, except for local and relatively small patches of Precambrian and Palaeozoic sediments, Pleistocene and Recent fluviatile material, is underlain by Precambrian granites and gneisses.

The granites and gneisses present a somewhat uniform appearance and yet it may be said that no two outcrops are similar. Over certain large areas a red gneiss predominates, while over others a pink or grey colored granite and gneiss is by far the more abundant. Within these granites and gneisses are patches of all sizes and shapes of dark biotite, hornblende-rich rocks. In the grey granites and gneisses these dark areas are invariably porphyritic, having phenocrysts of white or grey feldspar scattered through them. In the red gneisses the dark patches usually lack this porphyritic texture, but show a greater diversity in mineral composition.

TABLES OF FORMATIONS

Tyrrell, G.S.C.,Ann.Rept.,1895		Camsell, Memoir 84, 1916		Alcock, G.S.C., Summ.Rept.,1916		
Recent	Present lake beaches and flood plains of the present streams	Recent	River deposits, lake beaches	Quaternary	Recent	Beaches, bars, spits, dunes, stratified lacustrine clays
Pleistocene	Sand plains, ancient shore lines, till, drumlins	Pleistocene	Glacial deposits, sand plains, moraines and boulder clay		Pleistocene	Till, moraines and sand plains
Cambrian	Athabaska sandstone (Keewenawan), red sandstone and mottled sandy shale in more or less horizontal position		Unconformity		Unconformity	
					Athabaska series	Sandstone, arkose conglomerate. Trap flows, sills, dykes.
Huronian	White quartzites, fine grained red calcareous sandstone, hälleflintas and thinly foliated green schists	Precambrian	Athabaska sandstone (sandstone and conglomerate) Unconformity Granite and gneiss Intrusive contact Tazin series (mica, chlorite and quartz schists, shales and limestone)	Precambrian	Unconformity	Granites and gneisses
Laurentian	Hornblende and mica granites, granatoid gneisses, norite and gabbros, often showing signs of severe crushing and contortion				Igneous Contact	Tazin series - quartzites, dolomite and limestone, slate, schist, breccia
					Unconformity	Gneissic complex (including undifferentiated Precambrian) Intrusive rocks of various ages - granites, gabbro, amphibolite, norite, diabase.

Discussion of Classification

Owing to the remoteness of this district from type localities, it is, in the writer's opinion, impolitic to apply to the rocks in the area under discussion any of the definite time terms allotted to similar rocks in eastern Canada or the lake Superior region. With this in mind, the best that can be done is to attempt to place the various formations in their relative age positions.

While the lithological and structural features of these rocks are similar to those of the type areas, these are hardly sufficient evidence on which to base a definite time classification. In places the intrusive relations are very similar to those of the lake Superior region, but the intruding rocks may, or may not, be of the same age. One example of this is brought out by the Athabaska sandstone. This has been placed in the Keewenawan because of similarity of both the lithology and intrusive relations with those of the Keewenawan of the lake Superior region. Both series are, however, of continental origin and thus transitional, and in two such widely separated areas the time interval between the deposition of the one and that of the other may well have been considerable. The writer can see no reason why the lithological character of the Athabaska sandstone and the relation to it of intruded diabase sills can be taken as sufficient evidence for definitely placing this series as equivalent to the Keewenawan. They may well mark terrestrial conditions in early Palaeozoic time. About the only definite

statement that can be made is that they are post-Tazin and pre-Silurian.

The following table of formations is given as more nearly representing the present knowledge of the age relationships.

TABLE OF FORMATIONS

Cenozoic	Pleistocene and Recent		Present lake beaches, sand spits and bars, alluvium, deltas, swamps. Till, sand plains, old lake beaches, boulder pavements.
Palaeozoic	Devonian		Limestones, limy shales, dolomite.
	Silurian		Gypsum, anhydrite and associated limestones and dolomites.
Precambrian			Unconformity.
		Post-Tazin series	Athabaska sandstone, conglomerate, arkose. Conglomerate and arkose.
			Unconformity.
		Igneous intrusives	Granites, gneisses, pegmatites, injection gneisses.
			Intrusive contact.
		Tazin series	Quartzites, arkose, metamorphic arkose, chlorite and hematite schists, slates, reabsorbed arkoses.
			Unconformity - inferred.
		Pre-Tazin	Chiefly biotite and augen gneisses.

DESCRIPTION OF FORMATIONS

Pre-Tazin

The most important outcrop of these rocks occurs in the vicinity of Fishery bay, where they may be traced inland for a distance of several miles. Smaller and more local outcrops occur scattered throughout the eastern area. None of the rock exposures examined in the western area adjacent to Slave river showed rock types which could be definitely correlated with the typical augen gneiss about Fishery bay. Certain of the darker phases in the gneisses of the western area, particularly around Chipewyan, in the vicinity of Flett lake and La Butte creek, showed coarse feldspar aggregates in banded structures. These may represent remnants of the pre-Tazin rocks.

The pre-Tazin consists almost entirely of a well-banded, biotite (hornblende) augen gneiss. The gneiss consists largely of a dark green biotite in which occurs many phenocrysts of feldspar an inch or more in length and larger augen-shaped masses of a feldspar-rich rock. These latter sometimes are 10 feet long by 5 feet wide. The phenocrysts and augens are in general parallel to the gneissic structure, which in the vicinity of Fishery bay strikes a few degrees east of north. In many instances smaller augen masses and feldspar phenocrysts are clustered around the larger feldspathic masses. In some cases it appears as though the feldspar augens must have been present before the final gneissic structure was imposed, as they are often

fractured and tailed out with the laminated micaceous minerals forking around them.

Microscopic examination (e.g. slide C-23) shows the rock to be essentially a feldspar biotite gneiss. The feldspars are mostly altered orthoclase augens and phenocrysts. The latter show twinning while the former are apperently untwinned. The groundmass is pleochroic, laminated, green biotite, occurring as sub-parallel bands which bend around the augens.

Tazin Series

In the area under discussion this series, as described by Alcock, outcrops along the north shore of lake Athabaska from a point a few miles north of Sand point to the vicinity of Fishery bay. From this point it was traced inland for a distance of eighteen miles.

The series consists in the main of various kinds of arkose, slates, quartzites, chloritic and hematitic schists. All the beds dip at high angles (70 to 90 degrees) toward the granitic gneiss, which lies only a few hundred yards, and in some cases a few hundred feet, inland. The strike is in general parallel to the shore. Toward Sand point the series strikes from N.5°E. to N.50°E. About half way between Sand and Big points, it varies from N.36°E. to N.45°E., and in the vicinity of Fishery bay is more constant, varying from N.20°E. to N.25°E.

Proceeding northward along the shore of Athabaska lake,

the first member of this series to be encountered (Loc.48, Plate I) is a purplish, reddish and grey, interbedded arkose, striking N.50°E. and dipping 55° to the west. Thin section shows part of the exposure to be a metamorphosed arkosic sandstone; another part is made up of fragments of slate or shale cemented by carbonates and micaceous material. It is possible that these may be early post-Taxin, although field relations do not indicate this.

Half a mile further north (Loc. 46, 47, Plate I), outcrops of interbedded grey slate and purplish quartzite occur, the latter showing ripple marks and crossbedding. Quartz and pegmatite stringers cut these parallel to the bedding.

A quarter of a mile further north (Loc.44, Plate I) and extending along the shore for a distance of half a mile, occurs a grey to blue slate which strikes N.29°E. and dips from 48° to 60° to the west. This slate is made up of small quartz and feldspar fragments through which is shredded micaceous material.

The next outcrop of sediments of any importance occurs four miles north along the shore (Loc.59, Plate I). Here, at the water's edge, is exposed a green, fissile, foliated and contorted chlorite schist, striking N.63°E. and dipping 65° to the west. The exposure extends for a distance of 40 feet across the strike. Occasionally near the water's edge outcrops stand up from 10 to 15 feet, forming headlands. Back of these schists and rising 20 to 40 feet above the lake bed, occur somewhat massive quartzite beds ranging in thickness from 2 to

14 inches. In thin section these quartzites are seen to be a metamorphosed quartz feldspar mud. Locally they are stained very red by iron oxide. They show local slumping, minor movements, and, like the schists, are cut by quartz and pegmatite material.

For the next three miles along the shore (from Loc. 59 to Loc. 58, Plate I), the Tazin series is continuously exposed, sometimes just at the water's edge and extending inland only a short distance, at other times rising as high as 40 feet. The exposures show interbanded chlorite schists, red quartzites, red, grey and blue slates. Locally within these banded slates occur contorted hematitic schists. Along this stretch the dip varies from 70 to 80 degrees to the northwest, or toward the granite gneiss which domes up from 100 to 300 feet inland. In thin section these rocks are seen to be chiefly silicious arkoses and slates, one being an arkose breccia (No. C-64).

Following this exposure there is a distance of three-fourths mile in which none of the typical Tazin rocks are exposed. They then outcrop again (Loc. 50-56, Plate I), striking from N.24°E. to N.26°E., and are made up of schists, arkoses and gneisses. These latter are gneissic due to quartz being introduced, lit-par-lit, along the old bedding, or into arkoses that have been metamorphosed to a gneiss-like aggregate. A suite of specimens (50 to 56) taken across the strike at this point shows very well the nature of the metamorphism. From the shore inland, the feldspars of the arkose, the quartz, and the

general structure, show increased crushing and fracturing, and the conversion of biotite to chlorite becomes more pronounced. Near the shore and further from the gneiss, introduced quartz is more abundant.

Just north of this point the shore of the lake begins to bear further to the east. Thus the sediments that have been striking a few degrees east of north and parallel to the shore, now strike inland. Their location is marked by a depression in which lies a chain of lakes, trending in a general north and south direction, or at right angles to the general and major depressions and lake basins.

The Taxin series as traced inland is not continuously exposed, but may be picked up at intervals (Loc. 35.4, 34.4, Plate I) along the line of strike. Also, as it is traced inland, the width of the series increases. The series loses its well-banded character and appears to have suffered greater assimilation and alteration, only the more acid phases being left. A characteristic residual is a dense red feldspathic quartzite. As probable further evidence of this greater assimilation, the depression is bordered on the east and west by a highly contorted, dark green or dark reddish flow gneiss.

Thin sections taken from the central portion of these engulfed sediments show the rocks to be highly metamorphosed arkoses and siltstones. In the latter the argillaceous material has been changed to sericite. In many, infiltration of quartz may be seen, while in others rounded grains of the more resistant

minerals are common.

Intrusive Contact. Alcock[5] and others state that in certain districts the Tazin series has undoubtedly been intruded by granite or granite gneisses, but at other points the relation is not as evident.

In the area under discussion, the Tazin series has undoubtedly been intruded by igneous rocks. The relation of these sediments to the intruding rock, namely the fact that they dip toward the intruding body, indicates that prior to this intrusion the sediments were folded and tilted by an earlier igneous activity. Just how great was the time interval between the folding and the later intrusion, it is impossible to determine, as is also the effect this earlier folding had in developing the present lithology.

The intrusions of granitic rocks into the older sediments is in no place marked by a sharp contact. The contact is represented by a zone of highly contorted, for the most part dark, flow gneiss which grade on one hand into definitely metamorphosed sediments, and on the other into more massive granitic rocks.

Igneous Intrusives

Granites and Gneisses. By far the greater part of the country north of Lake Athabaska is underlain by granites and gneisses. These rocks present such a variety of structure and

rock types that they form a difficult group to describe. Separation or classification may be considered in three ways: (1) general appearance, (2) structure, (3) mineralogical composition.

(1) General Appearance. On this basis they may be separated into red and grey gneisses. Though gradations between these occur, broad areas may often be differentiated on this principle. Applying this to the area under discussion, the gneisses east of the chain of lakes running north from Fishery bay are predominantly grey. West of this trough the rocks are predominantly red and continue so to the vicinity of Shelter point, where the grey variety again becomes prominent. The grey variety then predominates to the vicinity of Chipewyan. Here a well banded red variety comes in, which extends west to Slave river.

(2) Structure. On this basis they may be separated into massive granites, and gneisses, the latter in some cases becoming almost a schist.

Within the area it is difficult to outline the granites. They grade practically impercepitably over to gneisses. Thin section shows them to have suffered fracturing and strain practically to the same extent as the gneisses. In fact, except for the parallel arrangement of minerals which characterize gneisses, they are similar to them, and would be, and are considered gneisses by many writers. On the whole the rocks that have been called granites are medium textured. In the

grey granite areas, parts of the granite show a fine graphic intergrowth. This feature was not observed within the red granite.

The gneisses may be subdivided into flow gneisses, "block" gneisses and schist gneisses. The flow gneisses are most prominent in a zone bordering the old sediments. They are characterized by a highly contorted banding, a dark green red color and a greater variation in mineral composition. These gneisses in all probability represent a zone of assimilation of the Tazin rocks by a granitic magma. The gneissic structure appears to have been imposed prior to final consolidation.

The term "block" gneiss has been coined to apply to certain gneissic structures which occur most prominently within the grey granite. They (the gneissic structures) are due to the aligment of large and small blocks of dark porphyritic gneiss or schist, remnants of an older and intruded series which formed a roof for the magma while it cooled. No better word picture of these can be given than that applied by Collins[9] to a phase of the pre-Huronian granite gneisses of the north shore of lake Huron (although no correlation is implied here):

> "Nearly everywhere the contact between the granitic gneiss and the older rocks is a zone rather than a line. Let us suppose that the granite gneiss is being approached from the schist area. Its proximity is first indicated by dykes and fingers of the granite in the schist, which tend to follow the schistosity planes where such planes are well developed. They become progressively larger and more numerous towards the granite. By degrees the relative proportions of schist and granite gneiss are reversed until there is a continuous matrix of granite gneiss holding masses and smaller fragments of recrystallized schists. At about this point it can be seen that the larger inclusions of

schist have fractured into swarms of smaller ones which floated apart and began to be rounded and reduced in size by the digestive action of the granitic magma before it solidified. Here the granitic gneiss, ordinarily poor in dark minerals, becomes so basified and charged with hornblende (with biotite in the area north of lake Athabaska) as to produce diorite and other rock types intermediate between diorite and granite.

"Although the contact or 'transition' zone so produced is most strongly developed as a fringe about half a mile wide around the schist areas, there are not many square miles of granite gneiss, even far away from any schist area, in which some basic intrusions cannot be found. In most of the North Shore district (as also in the district north of lake Athabaska), the inclusions retain their block form fairly well. Less commonly they are drawn into ribbons so as to produce a more or less foliated black and white hornblende gneiss, presumably as a result of movement in the magma after it had become viscous."

Locally and for only short distances, due to intense drag folding and differential pressure, the rocks have developed into schist-like gneisses.

Closely associated with the Tazin, in places where the intruding gneiss is not far removed, occurs a peculiar rock, green in color and somewhat gneissic. In places it is more red than green, due to the presence of pebbles of red feldspar. Some of these are circular and others are drawn out along the schistosity planes. In addition there are numerous irregular pieces of slaty or shale material. These (the slate and the shale, the pebbles of feldspar) are cemented by a dark green chlorite. This chlorite is arranged in a sub-parallel way and is responsible for the gneissic structure. This gneiss was probably formed soon after the tilting of the Tazin rocks, and to it has been applied the name arkosic gneiss.

3. Mineralogical Composition. Classification on this

basis will of necessity give rise to a greater number of rock types. They vary from acid to basic in character, many being best classified as transitional phases between granite and the more basic rock types. Because of this transitional character, the field boundaries are very difficult to determine.

The mineralogical composition of the rock types will be given under Chapter V, but a word may be said here regarding pegmatites and pegmatitic phases.

Pegmatites and pegmatitic masses are common throughout all of the granitic and gneiss areas. They occur as relatively narrow and short dykes, and as masses. The dykes strike in no particular direction, nor are they associated with any particular rock types or structures. They are all coarsely crystalline and are composed chiefly of coarse red feldspars. They probably represent a further product of differentiation in the original cooling magma.

Collins[9] has said:

> "It is quite likely, though difficult to prove, that rocks which are biotite-bearing in one locality, hornblende-bearing in another, grey in one place, red in another, are distinct intrusions and that the batholiths are the result of a complex series of intrusions."

In the area north of lake Athabaska the relations of the granites support the view that they belong to one major batholith, or at least contemporaneous intrusions, and that the red color imparted to some of them has resulted from iron oxide acquired from older and intruded sediments. This view is also supported by the fact that the red granites and the basic inclusions in

them show a greater diversity in mineral composition as compared to the grey.

In this section the grey granite, especially along its western margin, shows structures abnormal to an ordinary granite. There appear two distinct feldspars, one highly altered, showing smooth and in many cases rounded outlines, the other relatively fresh. Also there is a greater variation in grain size than is commonly found in a normal granite. Small irregular grains of feldspar associated with quartz often act as interstitial material to the larger grains. Also the range in basicity of the feldspars is greater than is normally found in a granite, and one cannot help but feel that this phase of the grey granite represents a highly absorbed arkose to which it is difficult to apply any of the ordinary rock terms.

Minor movements have taken place throughout the granites and gneisses, subsequent to consolidation. This is everywhere remarkably well shown by the offsetting of the gneissic bands, of the later dykes and of later quartz veinlets.

Post-Tazin Series

Conglomerate and Arkose. Along the north shore of lake Athabaska, where the tilted Tazin rocks are prominent, there occur several outcrops of a variegated arkose.

This arkose is underlain locally by a thin bed of altered conglomerate which lies unconformably on the upturned edges of

the Tazin slates and quartzites. This conglomerate is made up of rounded and partly rounded fragments of slate, quartzite and quartz, cemented by ferruginous material.

The arkose outcrops along the shore, forming cliffs from 30 to 40 feet above the lake level. In color it varies from white or yellow, to purple or light red, the latter two colors being due to a greater concentration of red iron oxide. In texture and composition it is typically arkosic, made up of kaolinized feldspar fragments cemented by clear unstrained quartz. The outcrops are irregularly and highly fractured.

The present exposures of this arkose are, in all probability, the remnants of a once much more extensive series. Inland from the shore of lake Athabaska and east of Slave river, small patches of a very similar but slightly coarser grained arkose are found.

It is possible that the material for this arkose was derived from the granitic rocks that intruded the Tazin series. As this arkose and Athabaska sandstone both unconformably overly the Tazin, and at no great distance from one another, it is quite possible that the sandstone was, in part at least, derived from the arkose.

Athabaska Sandstone. In the region under discussion, at various points along the north shore of lake Athabaska occur outcrops of cross-bedded, reddish tinted, occasionally conglomeritic sandstones. These are lithologically similar to sandstones found on the south shore by McConnell and called by him the Athabaska sandstone.

Alcock[5] has reported upon these occurrences of this series as follows:

> "Between Sand and Big points are a number of small patches of the same series. ...... The outcrops of sandstone rest on truncated edges of the Tazin quartzites along the shore of the lake. The base of the series is here a feldspathic sandstone, but 3 feet from the bottom is a bed of conglomerate 2 feet thick. The sandstone is thick-bedded, is much broken, and breaks equally well in any direction. Bedding is shown by red and yellow color banding and by the presence of conglomeritic beds. The series is cross-bedded in a more irregular manner than is usual in the series.
>
> "In this area better idea of the topography upon which the Athabaska series was deposited can be obtained than in the other districts where contacts were found. The relief was evidently considerable, for the adjacent hills stand up 300 feet above the level of the sandstone outcrops. Though the latter as a rule lies flat, at places they have a dip as high as 30 degrees following the contact with the Tazin rocks below. It suggests a deposit washed down from higher land to the northwest."

One particular exposure 10 miles northeast of Sand point is worth further mention. Here the exposure shows a red, cross-bedded coarse sandstone outcropping over considerable distance along the shore. The contact between the Athabaska sandstone, lying practically horizontal, and the underlying interbedded quartzites and schists, standing almost vertical, is clearly seen. The outcrops of Athabaska sandstone are localized close to the shore and show areas of highly folded and contorted Tazin rocks protruding through them. The Athabaska sandstone shows in places a conglomeratic phase consisting of well-rounded, large pebbles of quartzite, greenstone and schist imbedded in an evenly textured reddish sandstone. At other points, closely adjacent, the bottom bed appears as a red, cross-bedded sandstone,

with the bedding standing almost vertical where the sands as originally laid down were collecting upon an irregular shore of Tazin rocks. The conglomeratic phase seems to have formed behind the higher points of the old shore while the sands were washed about the lower slopes. The Athabaska sandstone is now firmly cemented to the rocks upon which it was laid down, whether they are the upturned edges of quartzites or shales or the weathered surface of the more metamorphosed types.

The contact between the Athabaska sandstone and the underlying tilted metamorphic rocks here shows ordinary shoreline conditions. The gravels and sands were mixed together on a rocky fore-shore identical with the gravel and sand associations at present accumulating on the rocky shore of present lake Athabaska. Thus the present shore of lake Athabaska at this point appears to have been a shore line (presumably of fresh water) at the time when this portion of the Athabaska sandstone was laid down.

Pleistocene and Recent

As has been previously stated in Chapter III, the basin of Athabaska lake, although of pre-glacial origin, has been considerably deepened and broadened by glacial action.

In the areas under discussion, the evidences of glaciation are very well marked. They show as glacial gouging and striae on practically every exposed rock surface; by rounded and roches

moutonnees hill types, and on a still larger scale by the general trend of the numerous lake basins and stream courses as shown on the accompanying maps. The general direction of the ice movement has been from the east. Along the shores of lake Athabaska and in the district examined north of the lake, numerous determinations of the glacial movement as represented by glacial striae and gouging showed this direction to be predominantly S.89°W. Local variations were noted parallel to and on the sides of small valley troughs.

In the western area adjacent to Slave river, Precambrian rocks where exposed also show evidence of glacial erosion. Numerous determinations of glacial movement in the region showed the direction here to be predominantly N.65°W. This is 26 degrees more to the north than the general direction of movement as determined about Athabaska lake.

On the retreat of the Pleistocene glaciers, the general topography of northern Alberta clearly indicates that extensive and glacial lakes were developed. Different stages of these lake expanses have been outlined by Cameron.[8]

At a number of points in the eastern area examined, there were found distinct evidences of these post-glacial lake expansions. For example, on the east side of the bottom of Big bay there is exposed an outcrop of flat-lying Athabaska sandstone at an elevation of 120 feet (bar.) above lake Athabaska. These sandstones show a wave-cut escarpment 10 to 15 feet high with several shingle beaches, both above and below the escarpment. The

portage trail north from Fishery bay about one mile inland passes along the foot of a typical relic beach which lies at approximately the same elevation as the wave-cut cliff mentioned above. Furthermore, on the shores of the inland lakes there occur stretches of sandy, jack pine forested plains occasionally showing sand dune structures. These plains stand at an elevation varying from 5 to 25 feet above the present lake levels. The lakes themselves are all of about the same elevation, namely, 150 feet (bar.) above present lake Athabaska. They are joined or drained by small streams of slight gradient in valleys that are frequently choked with glacial boulders. The outlet of every lake is now practically closed by a sand bar lying on a boulder pavement, and the water has to filter through this accumulated mass of debris. These lakes are all well stocked with fish: whitefish, trout and Jack fish, a fauna generally similar to that found in lake Athabaska. It is quite apparent that this fauna cannot have migrated by way of the present stream courses and must have been land-locked ~~when~~ by the recession of the ice lowered post-glacial lake Athabaska. It appears as though these inland lakes are the present day representatives of a fairly definite stage of post-glacial lake Athabaska.

Recent deposits in the area in the form of river sands and silts deposited by Athabaska and Peace rivers are described in Chapter III. Lacustrine sands form beaches and sand dunes at many points along the shore of Athabaska lake, particularly to the east of Big point. The origin of these sands is

undoubtedly the same as those that form the extensive sandy areas on the south shore, which are presumed to be derived from the Athabaska sandstone.

Samples of sands were collected from the beaches and sand dunes on Athabaska lake shore and also from the relic beaches in the interior country. These were sized on standard Tyler screens in a Rotap machine, and portions of each size studied microscopically.

Grains greater than .58 mm. in diameter invariably showed some rounding, dulled surfaces, and the absence of sharp, keen edges. About 60 per cent of the grains from .58 to .29 mm. in diameter showed rounding and dulling. Grains from .29 to .20 mm. showed less rounded and brighter surfaces, and in grains from .20 to .14 mm. in diameter, only a very small percentage showed any effect of abrasion.

Throughout the sands examined there were only occasional grains of any mineral other than quartz. The quartz grains were of two kinds, one clear and uncolored, the other stained red by iron oxide. The iron stained grains in practically every case within the same size limits, showed a much greater degree of rounding than the uncolored grains.

Samples of sand collected from the beach dunes east of Big point showed a remarkable degree of sorting. The grains were of two sizes: from .20 to .14 mm. and from .14 to .10 mm. in diameter. The quartz was clear, glassy, transparent and angular with sharp edges and keen points.

One mile north of Fishery bay occurs an old beach or shore line; a similar beach occurs at the outlet of Flett lake. Samples of sands were collected from these two beaches. The two samples were of the same general character. They showed little sorting and the grains were generally sharp, angular, fresh and bright, with little evidence of wear. Many of them showed the characteristic conchoidal fracture of quartz. Grains greater in size than .53 mm. were rounded and dulled, showing the effects of water abrasion. Many of these dulled grains were broken across as though crushed. In these samples, like the others from inland lake beaches, the red stained grains showed the most rounding. The old beach sands differ, however, in having a considerable quantity of material less than .07 mm., which appears as a rock flour. This, under high magnification, is seen to be made up of sharp, angular fragments of clear quartz, and an indefinite powder.

The sands from these old beach shores, now about 100 feet above the present level of lake Athabaska, are distinctly glacial in character, and suggest that these beach lines were formed from glacial sand material, reworked by wave action for a relatively short period.

Economic

As Camsell[3] has stated, the areas most likely to contain mineralization of economic value would be those districts underlain

by or adjacent to the Tazin sedimentary series, and particularly to the contact zone of these sediments and the intruding granites.

In the area under discussion there is no evidence of mineral-bearing offshoots from the intruding granites. There is, in fact, a remarkable absence of sulphide or other mineralization. Although pegmatites and quartz veins are common, they proved in every case examined to be barren.

Everywhere throughout the region it was noted that the highlands or hills were composed mainly of granites or granite gneiss, and that wherever areas of the softer basic inclusions or remnants of absorbed sediments were found they predominantly margined lake basins or depressions. If mineralization is to be looked for within these regions, examination can be safely confined to the shores and islands of the lakes and depressions between the hills.

CHAPTER V

PETROLOGY OF THE ROCK TYPES

As far as possible, the thin sections representing one type of rock will be grouped together and the features common to them all tabulated. Because of the many gradational phases and types present, it is, in many cases, difficult to place an individual in its proper group. The grouping, therefore, can be considered as only approximate. Detailed descriptions of each thin section will be found in the appendix. The following groups are considered:

1. Grey granites and gneisses.
2. Basic inclusions in the grey granite and gneisses.
3. Red granites and gneisses.
4. Basic inclusions in the red granites and gneisses.
5. Syenites.
6. Contact phase or zone occurring between the Tazin sediments and the granites and gneisses.
7. Metamorphosed sediments.
8. Metamorphosed arkoses (not typical Tazin).
9. Post-Tazin arkoses.
10. Tazin series:
    - (a) arkoses
    - (b) quartzites
    - (c) slates
    - (d) schists
    - (e) gneisses

1. Grey Granites and Gneisses

Thin sections of these (1, 24.1, 24B, 30.1, 317, 32.1, 36.1, 87, 84.1, 93, 104.1, 129, 132) show the following features:

1. Even or equitextured, medium to coarsely crystalline.

2. Feldspars: range from orthoclase to oligoclase (including some microcline and microperthite).

In most cases there appear to be two feldspars, one much more highly altered and showing smooth and rounded margins, often enclosed in or by a much fresher, usually more acid, often fractured, feldspar.

3. Quartz: shows marked undulatory extinction, occasionally not, especially where it can be seen to be later. Also the quartz in most cases shows crushing and granulation.

4. Biotite: on the whole sparingly present, it invariably shows alteration either to chlorite or iron oxide, or both. In a few cases the biotite shows bending and shadowy extinction.

5. Accessory minerals: apatite, titanite and garnet.

6. Alteration: the feldspars are commonly altered to sericite, kaolinite and epidote. Biotite as stated above.

7. Remarks: all of the thin sections show the granites to have suffered considerable dynamic metamorphism, apparently in many cases accompanied by hydrometamorphism. Garnet is found only in those sections taken from granites adjacent to Slave river.

2. Basic Inclusions in the Grey Granite and Gneiss

Thin sections of these (24, 32.5, 33.4, 104) show the following features:

1. Feldspars: range in basicity from albite to oligoclase and andesine.

2. Quartz: cracked and showing in most cases marked undulatory extinction.

3. Biotite: is abundant, pale brown, dark brown and green in color; shows marked pleochroism and often acts as interstitial material.

4. Accessory minerals: apatite, zircon, titanite, magnetite and epidote, commonly associated with the biotite of the rock.

5. Alteration: feldspars are commonly altered to sericite and kaolinite; biotite altered along margins to epidote.

6. Remarks. All the thin sections show the basic inclusions to have suffered crushing, which, in some cases, has fractured the more resistant minerals.

3. Red Granites and Gneisses

Thin sections of these (27, 35.1, 67, 94.1) show the following features:

1. Feldspars: vary considerably, orthoclase, microcline, microperthite, micropegmatite, all of which occur practically unaltered. In addition there is a large amount of highly clouded feldspar, on which no satisfactory determination could be made.

2. Quartz: both in uniform and undulatory extinguishing masses.

3. Biotite and chlorite: on the whole sparingly present.

4. Accessory minerals: magnetite, ilmenite, apatite, zircon, hematite and garnet.

5. Alteration: many of the feldspars are uniformly clouded by ferruginous material. Some of the iron oxide appears

to be an alteration product of the iron-rich minerals.

6. Remarks. The rocks on the whole have suffered severe strain but little crushing. One exceptional feature is the presence of well crystallized green epidote (thin section 27), which crosses the thin section in a well defined band.

4. Basic Inclusions in the Red Granites and Gneisses

Thin sections of these (68, 72, 79) show the following features:

1. Holocrystalline, equitextured.

2. Feldspars: basic; ranging from microcline to labradorite, the latter being the more common.

3. Hornblende and pyroxene (augite); fairly abundant.

4. Olivene: common in some of the basic inclusions.

5. Accessory minerals: magnetite, apatite, quartz and calcite.

6. Alteration: olivene shows alteration to antigorite, hornblende to chlorite, and pyroxene to chlorite and uralite.

5. Syenites

These thin sections (94, 99, 102) are representative of feldspar-rich phases of the granites and gneisses, which occur along the western margin adjacent to Slave river. They show the following features:

1. Feldspars: these minerals make up by far the greater part of the rock. They are mostly orthoclase, with some microcline and microperthite.

2. Quartz: an accessory, showing uniform extinction and appearing to have come in later.

3. Biotite: not abundant but occurs as cleavage flakes which show abundant pleochroic halos.

4. Accessory minerals: cracked garnets occur with certain of the feldspar-rich types; rutile is present as short needles in some of the quartz.

5. Alteration: on the whole is not extensive, and is commonly confined to the margins and cracks of the feldspars.

6. Contact Phase or Zone occurring between the Tazin Sediments and the Granites and Gneisses

Thin sections (4, 6, 17, 19, 26, 42, 58, 63, 119, 120) of the gneisses and porphyries occurring within this zone show the following features:

1. A porphyritic and gneissic texture.

2. Feldspars: in the porphyry types phenocrysts of orthoclase and microcline are common. The feldspars occur both fresh and altered.

3. Quartz: sutured borders, cracked and undulatory extinction. In some thin sections a later uniformly extinguishing quartz is quite common.

4. Micaceous material: abundant, especially in the more gneissic phase. It consists largely of green and brown biotite and chlorite.

5. Accessory minerals: occasionally hornblende. Apatite,

titanite and zircon are, on the whole, abundant.

6. Alteration: feldspars commonly show alteration to sericite, calcite and iron oxide; biotite commonly to chlorite, along with magnetite and epidote.

7. Remarks. All thin sections show the rocks of this group to have suffered considerable crushing. Some of them appear to have been derived from sediments.

7. Metamorphosed Sediments

This group refers to certain localized areas of red granitic-like rocks which occur, usually within the grey granite. In the hand specimen they appear granitic, but thin sections (34.6, 37, 38.2, 76, 84) show them to possess structures and features which are decidedly sedimentary.

1. Texture: usually somewhat porphyritic.

2. Feldspars: usually two, one highly altered and rounded, the other relatively fresh. Some of the feldspars stand out as phenocrysts, being surrounded by a fine-grained groundmass made up of fragments of feldspars, quartz and micaceous material.

3. Quartz: usually two, one cracked and showing undulatory extinction, and a later one showing uniform extinction. The latter occurs usually interstitially.

4. Biotite: scattered irregularly through the rock.

5. Accessory minerals: apatite, zircon, magnetite.

6. Alteration: feldspars, commonly altered to sericite and kaolinite. Excellent examples of biotite altering to chlorite.

7. Remarks. The thin sections on the whole appear decidedly sedimentary in character. Also these rocks have suffered considerable crushing, as shown by the cracked nature of the quartz and feldspar.

8. Metamorphosed Arkoses (not typical Tazin)

This group in general is similar to that treated under Syenites. The group possesses features which indicate that the members were originally arkosic.

Thin sections of these (73, 76, 82, 83, 114) collected along Rocher and Slave rivers, show the following features:

1. Feldspars: generally partly fresh and partly altered. Many of the altered grains show rounded outlines.

2. Quartz: most cases appear to be later; some slides, however, show an earlier quartz as well.

3. Biotite and chlorite: on the whole sparingly present, acting as interstitial material between the larger mineral grains.

4. Alteration: the feldspars have been altered to ferruginous material and sericite. Biotite in some cases is altered to chlorite.

5. Remarks. All show evidence of crushing, in the cracked and granulated character of the feldspars and quartz.

9. Post-Tazin Arkoses

Thin sections of these (12, 12.1, 16, 56, 60) show the following features:

1. Feldspars: practically all highly kaolinized grains.

2. Quartz: in some cases quartz acts as a cementing material; in others it occurs as grains and is cemented by kaolin and micaceous material.

3. Accessory minerals: magnetite and pyrite.

4. Alteration: feldspars are altered to kaolin, sericite and iron oxide.

5. Remarks. Iron oxide in some cases is present in sufficient quantities to impart a reddish tinge. In those sections showing highly cracked and undulatory extinguishing quartz, the quartz was probably derived from gneisses or granites and was subsequently cemented by kaolinite and micaceous material.

10. Tazin Series

(a) Arkoses

Thin sections of these (34.4, 62, 64) show the following features:

1. Feldspars: vary considerably as to size, shape and alteration. They occur as grains.

2. Quartz: chiefly as grains.

3. Remarks. Cementation of the feldspar and quartz grains has been largely by calcite, kaolinite, ferruginous and micaceous material.

(b) Quartzites

Thin sections of these (35.4, 45, 59) show the quartzites to be, on the whole, metamorphosed impure sands. Cementing material is largely quartz, micaceous material and calcite.

Under this group also may be included thin sections 35.3 and 46. These are very much like the quartzites, but represent more impure metamorphosed sandstone or siltstone.

(c) Slates

Thin sections of these (44, 61, 65) show the slates to be made up of fine fragments of feldspar, quartz and slaty material, cemented largely by fine micaceous material.

(d) Schists

Thin sections of these (21, 54, 55, 57) show the following features:

1. Feldspars: altered and in many cases highly iron stained.

2. Quartz: this mineral is of two periods, an earlier one incorporated in the schist, and a later uniform extinguishing quartz which in many cases cuts across the schistosity.

3. Chlorite: foliated chlorite in many cases makes up the entire rock; it is always responsible for the schisty character.

4. Alteration: feldspars to calcite, sericite, epidote and iron oxide.

(e) Gneisses

Thin sections of these (22, 50, 51, 52, 53) show the following features:

1. Feldspars: occasionally fresh, but for the most part highly altered and rounded.

2. Quartz: an earlier fractured and cracked quartz, and

a later uniform extinguishing quartz, introduced in parallel bands.

3. Biotite and chlorite: somewhat abundant.

4. Accessory minerals: magnetite, apatite, zircon and hematite.

5. Alteration: this feature showing chiefly in the feldspars and biotite.

BIBLIOGRAPHY

1. McConnell, R.G.: "Report on a portion of the district of Athabaska comprising the country between Peace river and Athabaska river north of Lesser Slave lake", Geol.Surv., Can., New Series, Vol.5, Part I, 1890-91, p.51D.

2. Tyrrell, J.B.: "Report on the country between Athabaska lake and Churchill river, N.W.T.", Geol.Surv.,Can., New Series, Vol.VIII, Part D, 1895, p.54.

3. Camsell, C.: "An exploration of the Tazin and Taltson rivers, N.W.T.", Geol.Surv.,Can., Memoir 84, Series No. 69, 1916.

4. Alcock, F.J.: "Geology of the north shore of lake Athabaska, Alberta and Saskatchewan", Geol.Surv.,Can., Summ.Rept. 1914, p.60.

5. Alcock, F.J.: "Black bay and Beaverlodge lake areas, Athabaska lake, Saskatchewan", Geol.Surv.,Can., Summ.Rept. 1916, p. 152.

   Alcock, F.J.: "Unpublished manuscript."

6. Camsell, C.: "Salt and gypsum deposits of the region between Peace and Slave rivers, northern Alberta", Geol.Surv.,Can., Summ. Rept. 1916, p. 134.

7. Allan, J.A. and Cameron, A.E.: "An occurrence of iron on lake Athabaska", Scientific and Industrial Research Council of Alberta, Fourth Annual Report, Part II, 1923.

8. Cameron, A.E.: "Post-glacial lakes in the Mackenzie river basin, etc.," Jour. of Geol., Vol.30, No.5, 1922, pp. 337-353.

9. Collins, W.H.: "North shore of lake Huron", Geol.Surv.,Can., Memoir 143, p.28.

APPENDIX

Detailed description of thin sections

THIN SECTIONS

✓ 1 Gneiss
— 2 Aplite
✓ 4 Microgneiss
✓ 6 Chloritic augen schist
× 11 Dark green gneiss with pink feldspar
— 12 Arkose
× 12.1 Arkose
× 16 Metamorphosed silicious arkose
✓ 17 Microgneiss
✓ 19 Feldspar porphyry gneiss
× 21 Ferruginous schist
✓ 22 Feldspar gneiss
23 Augen gneiss
✓ 24 Basic inclusion
✓ 24.1 Granite
✓ 24B Granite
✓ 26 Microgneiss
27 Granitic gneiss
✓ 30.1 Granite
✓ 30.5 Gneiss showing bands of feldspar
✓ 31 Metamorphosed granite
✓ 32.1 Granite (altered)
✓ 32.5 Biotite granite
✓ 33.4 Biotite granite
× 34.4 Metamorphosed arkose
✓ 34.6 Metamorphosed sediment
— 35.1 Granite
× 35.3 Metamorphosed siltstone
— 35.4 Quartzite
✓ 36.1 Granite
✓ 37 Metamorphosed sediment
✓ 38.2 Metamorphosed sediment
✓ 42 Feldspar biotite gneiss
× 44 Slate
× 45 Fine grained quartzite
× 46 Metamorphosed argillaceous sandstone
× 48 Arkosic gneiss
✓ 50 Injection gneiss
— 51 Intrusive gneiss
— 52 Microgneiss
✓ 53 Microgneiss
✓ 54 Chlorite schist
— 55 Schist
— 56 Arkose

Box 1
Box 2

✓ 57 Hematite schist
— 58 Chloritic magnetite gneiss
— 59 Impure ferruginous quartzite
✓ 60 Quartz-rich arkose
— ✓ 61 Silicious slate
— 62 Silicious arkose
— 63 Biotite chlorite (magnetite) gneiss
— 64 Arkose breccia
— 65 Slate
66 Crossbedded sandstone
✓ 67 Granite
✓ 68 Basic inclusion (gabbro)
✓ 72 Basic inclusion
✓ 73 Metamorphosed arkose
76 Metamorphosed sediment
✓ 79 Hornblendite
✓ 82 Highly metamorphosed arkose
✓ 83 Absorbed arkose
✓ 84 Granite (gneissic)
✓ 84.1 Granitic gneiss
✓ 87 Granite?
no slide 93 Altered granite
✓ 94 Syenite
94.1 Granite
✓ 99 Syenite
✓ 102 Quartz, garnet, syenite
✓ 104 Basic inclusion
✓ 104.1 Grey granite
✓ 114 Metamorphic arkose
✓ 119 Biotite augen gneiss
✓ 120 "Porphyritic" biotite gneiss
✓ 127 Quartz schist
✓ 129 Granite
✓ 132 Granite
✓ 138 Red sandstone (Athabaska)

Box 2
Box 3

✓ indicates rock returned by [illegible] from [illegible]

× indicates rock taken from storage at [illegible] after slides returned

— indicates rock spec missing.

49 × [illegible]

Slide number	C-1
Name	Gneiss
Locality	Shelter point, lake Athabaska, Plate I.

Macroscopic

A fairly coarsely crystalline aggregate of a dark grey color. The rock is made up of a grey colored feldspar with some pieces showing parallel striations; a clear glassy transparent quartz and biotite irregularly scattered throughout the rock.

Microscopic

The thin section shows the rock to be made up of feldspar, quartz, biotite, a few grains of apatite, zircon, and the secondary or alteration products pyrite, chlorite, sericite, epidote and iron oxide.

The feldspars range in composition from acid plagioclase to as basic as andesine, determined by the extinction angle perpendicular to the (010) face. Albite twinning is common. Many of the crystals appear fresh, others irregularly weathered and showing the alteration products epidote, calcite and kaolinite.

The quartz shows marked undulatory extinction occurring in granulated aggregates having marked sutured borders and containing numerous minute inclusions.

Pale brown pleochroic biotite is fairly abundant. The pieces are twisted and contorted, showing shadowy extinction from one end to the other. In places the biotite can be seen going over to chlorite, which shows a marked velvety blue color under crossed nicols. Both the biotite and chlorite are in places shredded and feathery.

Epidote, besides being in the feldspars, occurs marginal to the biotite.

Apatite and zircon are present, the former occurring as rounded grains or with definite hexagonal outlines.

Pyrite is sparingly present, some of the grains being surrounded by a rim of hematite.

The cataclastic nature of the rock is shown by the cracked and fractured nature of the feldspars and quartz. In the feldspars decomposition, due probably to solutions, has taken place along the cracks.

Slide number	C-2
Name	Aplite
Locality	A dyke cutting gneiss at Shelter point, lake Athabaska, Plate I.

Macroscopic

A fairly fine-grained, homogeneous, light grey colored rock in which quartz, a reddish feldspar and a few fine bands of biotite may be recognized.

Microscopic

The constituent minerals are quartz, feldspar, a small amount of calcite, sericite, biotite and chlorite, which are confined to cracks or seams. An occasional patch of pyrite is present.

Most of the quartz shows very marked undulatory extinction, sutured borders and granulation.

Feldspars are badly strained and cracked. The straining in some cases gives rise to a peculiar inter-toothed effect when the feldspars are rotated under crossed nicols. A set of parallel elliptical cracks also show as evidence of straining. The cracks in many cases are healed by micaceous material and carbonates. Twinning varies from fine to fairly coarse, even and uneven bands. A lattice twinning appears in some pieces, but does not appear to be the lattice twin of microcline.

Micaceous material and calcite have been introduced after the rock was crushed, as they are confined to cracks or act as infilling between the larger grains.

Slide number	C-4
Name	Microgneiss
Locality	Hill west of south end of lake No.1

Macroscopic

The rock is made up of a red feldspar, dark green chlorite and a relatively small amount of quartz. These minerals occur with no definite relation to one another, and yet the chlorite tends to show some alignment, the whole giving rise to a dark green, coarsely crystalline rock.

Microscopic

The rock is composed mostly of crushed and broken feldspar phenocrysts in a mass of fragmental feldspars. The phenocrysts

are of orthoclase and microperthite, the latter being fresh and showing well-defined cleavage traces.

Quartz is present in the groundmass, as irregular, suture margined, undulatory extinguishing grains.

Magnetite in small irregular grains and closely associated with chlorite is scattered through the rock.

Most of the zircons present show well-defined outlines.

Traversing the thin section are streaks of micaceous material which winds its way among the grains and into the larger cracks. The crushing and gneissic character was probably impressed on the rock prior to consolidation, as many of the crystals appear bent or twisted.

Slide number	C-6
Name	Chloritic augen schist
Locality	From ridge one-half mile southeast of lake No.1

Macroscopic

The rock has a poorly developed schistosity, the banding being due to dark chlorite and quartz aligned in a common direction. Throughout the rock are relatively large and small augens of reddish feldspar. These augens are in many cases fractured and tailed out parallel to the schistosity. The micaceous material is chloritic in appearance, is bent and twisted around the feldspar augens, and exhibits the characteristic sheen of chlorite shown in chloritic schists. A later developed quartz than that mentioned above cuts across the schistosity and fills in cracks in the feldspars.

Microscopic

The feldspars are all highly altered, in some cases converted almost entirely to sericite, in others, parts of the crystal have disappeared and have been replaced by fine-grained quartz.

The two quartzes mentioned under macroscopic characteristics are quite noticeable in thin section. The earlier quartz appears in fairly large masses, all of which are fractured and show marked undulatory extinction. This quartz is commonly surrounded by fine-grained or granular quartz which shows little or no shadowy extinction. The uniform conditions under which this later quartz was formed is shown by the fact that much of it shows regular inter-granular boundaries.

Pale green pleochroic chlorite, through which is scattered numerous pieces of magnetite, is quite common. Within the chloritic areas are small, faint brown, slightly pleochroic patches which show cleavage traces. These are possibly remnants of biotite from which the chloritic material, accompanied by the liberation of iron oxide, has been derived.

The thin section shows decided banding, the banding being due to the common alignment of feldspar patches, minute micaceous flakes and parallel bands of clear quartz.

Slide number	C-11
Name	Dark green gneiss with pink feldspar
Locality	North shore lake Athabaska, Plate I

Macroscopic

A dark, dull green rock, through which is scattered reddish feldspar, giving the whole a speckled appearance. Specimens vary in texture from massive to gneissic to schistose.

Microscopic

Feldspars are all highly altered except for one piece which shows a central, finely twinned area. Alteration is chiefly to epidote? and sericite.

Quartz occurs in highly undulatory extinguishing masses with marked sutured intergrowth.

Green chlorite through which is dotted magnetite, occurs marginal to and parallel with the feldspars.

A few rounded grains of apatite, one of pyrite, and small seams of calcite filling cracks, make up the remainder of the slide.

Slide number	C-12
Name	Arkose
Locality	North shore of lake Athabaska, Plate I.

Macroscopic

This rock on the whole is of a pale grey or cream color, with often the weathered surface taking on a yellowish or brownish tinge. It appears granular in structure and under magnification

is seen to be made up of small, highly kaolinized pieces of feldspar, around and through which passes clear, transparent quartz.

Microscopic

In thin section the rock is seen to consist almost entirely of weathered feldspathic material, around and through which is clear unstrained quartz. It appears to have suffered no crushing or fracturing. Sericite and kaolinite are abundantly developed. Magnetite, limonite, pyrite, hematite and a few flakes of mica are scattered throughout the slide. The hematite has been derived from the magnetite and pyrite.

Slide number	C-12.1
Name	Arkose
Locality	Same as C-12

Macroscopic

Is of the same general appearance as specimen C-12, only that in outcrops this particular phase has a distinct purple tinge.

Microscopic

Is practically identical with slide C-12. In this thin section (C-12.1), however, there is a much greater amount of feathery magnetite which is coated with a film of hematite. Hematite also present as transparent, blood-red grains. This greater predominance of hematite is, in all probability, responsible for the purplish tinge seen in the outcrops.

Slide number	C-16
Name	Metamorphosed silicious arkose
Locality	North shore of lake Athabaska, Plate I.

Macroscopic

In the hand specimen appears as a massive, fine-grained purplish quartzitic mass. Traversing it are ramifying seamlets of limonitic material. Hard, cream-colored, cherty and clear quartz areas are present.

Microscopic

A fine, compact textured rock, which has apparently

suffered considerable crushing, thus aiding or enabling decomposition of the minerals to go on more readily. Strain shadows are common, both in the feldspars and quartz. One very noticeable feature is the abundance of hematite. This hematite has been derived from the feldspars and not brought in by later solutions, as cracks within the altered feldspars are free of this mineral. Fractures and cracks are healed by fine micaceous material

On the whole is very similar to thin sections C-12 and C-12.1, the greater abundance of hematite and shadowy extinguishing quartz being the chief difference.

Slide number	C-17
Name	Microgneiss
Locality	North shore lake Athabaska, Plate I.

Macroscopic

This rock is practically the same as that described under C-4. The percentage of ferro-magnesium minerals is higher, the rock finer grained and more banded.

Microscopic

Is essentially made up of altered feldspar, quartz, chlorite, leucoxene!, magnetite or ilmenite?, apatite, and the accessory minerals titanite, sulphide and zircon.

The feldspar occurs as irregular, considerably altered patches clouded with sericite, iron oxide and other secondary products.

Quartz shows undulatory extinction and sutured borders.

Chlorite is scattered throughout the thin section, showing in places the cleavage of some pre-existing mineral.

Apatite and titanite are abundant, the former occurring in rounded, lozen-shaped grains and grains showing transverse sections. The titanite is irregularly distributed in relatively fresh but fractured masses and has closely associated with it leucoxene.

Magnetite or ilmenite? occur scattered through the chlorite.

A few grains of zircon, pyrite and a little calcite make up the remainder of the thin section.

Slide number	C-19
Name	Feldspar porphyry gneiss
Locality	North shore of lake Athabaska, Plate I.

Macroscopic

A dark colored rock through which is scattered phenocrysts of whitish feldspar. On the polished surface the groundmass can be seen crowded around the phenocrysts. This rock represents a border phase of the red gneiss of this district.

Microscopic

Porphyritic texture. The feldspars occur chiefly as phenocrysts. The majority of these are unaltered and show no twinning. One feldspar shows a marked bent rib structure. Some of the feldspars are shattered and alteration (calcite and sericite) has set in along the cracks so produced.

Quartz occurs in undulatory extinguishing grains, apparently as a recrystallization product.

Chlorite, with which is associated magnetite, winds its way through the groundmass and is bent around the phenocrysts. Rounded apatite grains are common.

The groundmass is made up chiefly of chlorite and fragmental quartz and feldspar, these feldspar grains appearing to be more basic than the phenocrysts.

The cataclastic nature of the rock is remarkably well shown in the way the feldspars are cracked and "faulted", slipping or offsetting having taken place along cleavage planes. Much of the quartz is also cracked and these are healed by fine greenish groundmass material.

Slide number	C-21
Name	Ferruginous schist
Locality	North shore of lake Athabaska, Plate I.

Macroscopic

A red, highly foliated schist, through which cuts stringers of quartz.

Microscopic

The schist is made up of very fine micaceous material (chlorite, sericite), highly foliated, across which cuts typical,

uniform extinguishing, vein quartz. Quartz is also seen filling vugs. The micaceous areas seem to have, in many cases, the outline of former crystals.

All of the thin section except where cut by quartz is highly stained by hematite.

Slide number	C-22
Name	Feldspar gneiss
Locality	Three-quarters of a mile northwest of Fishery bay, Plate I.

Macroscopic

A fine-grained, pink colored rock, made up of feldspar augens, micaceous material and quartz. A distinct banding is also evident.

Microscopic

A fine-grained rock made up chiefly of feldspar and two generations of quartz. Most of the feldspar occurs as fractured, relatively fresh, some finely twinned, augens, against which the finer grained groundmass abuts. The groundmass is composed of fragmental feldspar and quartz which show undulatory extinction. Occasional grains of magnetite, rounded grains of apatite and zircon?, along with chlorite and calcite, make up the remainder of the rock. The rock shows a decided banded character, due to the finer grained material being aligned and forking around the larger pieces of feldspar.

On the whole the rock appears as a silicious arkose that has been metamorphosed to a gneiss-like aggregate.

Slide number	C-23
Name	Augen gneiss
Locality	From shore at west point of Fishery bay, lake Athabaska, Plate I.

Macroscopic

A dark colored augen gneiss composed of fine-grained material with several phenocrysts of twinned feldspar, which show up as light colored spots on weathered surfaces. The rock is in part schistose and the schist forming minerals are seen to bend around the feldspar grains.

Microscopic

The rock is essentially feldspar, biotite, quartz, along with a secondary quartz, and the accessory minerals apatite, magnetite and pyrite.

The feldspars occur most prominently as altered orthoclase augens, with a few appearing fresh. Some augens show uniform, others slight undulatory extinction. Many of the grains of feldspar show twinning, but the augens are apparently not twinned.

Pleochroic brownish-green biotite is an abundant constituent. It makes up the greater part of the groundmass, occurring as parallel stringers which bend around the augens.

Primary quartz is present as irregular shadowy extinguishing grains scattered through the groundmass. A later quartz which shows uniform extinction occurrs as seams parallel to the stringers of mica.

The gneissoid structure is due largely to the parallel arrangement of the biotite and quartz.

Slide number	C-24
Name	Basic inclusion
Locality	Two miles upstream from mouth of Grey Willow creek, Plate I.

Macroscopic

A dark biotite-rich rock which occurs as patches in grey granite.

Microscopic

The rock is made up essentially of feldspar, biotite, quartz, with the secondary minerals calcite, sericite and the accessories apatite, zircon and titanite.

Most of the feldspar present is oligoclase, which in most cases is clouded by a thin, irregular layer of alteration products, mainly calcite and sericite?. Some show a poorly developed zonal growth.

Dark brown and light brown, highly pleochroic biotite is quite common. It occurs in irregular flakes through which is scattered numerous pleochroic and non-pleochroic halos.

The quartz present is considerably cracked and shows marked undulatory extinction, a feature not shown by the other minerals.

Apatite, zircon and titanite as accessories occur chiefly within the biotite and in one case a grain of titanite appears to act as a nucleus for apatite.

Slide number C-24.1
Name Granite
Locality Two miles upstream on Grey Willow river, Plate I.

Macroscopic

A grey (in places pink), even textured granite.

Microscopic

Thick section. There are two feldspars, an acid (orthoclase) and a more basic, twinned feldspar, which shows a much greater degree of alteration, being covered with a film of sericite. Feldspars also show undulatory extinction.

The quartz is badly cracked, has numerous ramifying lines of inclusions and shows marked undulatory extinction.

A small amount of muscovite and biotite, the latter in places going over to chlorite, makes up the remainder of the thin section.

Slide number C-24B
Name Granite?
Locality Two miles upstream on Grey Willow river, Plate I.

Macroscopic

A medium grained grey granite, through which is scattered small flakes of biotite.

Microscopic

The feldspars (orthoclase, microcline, micropegmatite and oligoclase) appear altered and unaltered. Alteration in some has taken place more or less uniformly, going over to fine

sericite; in others alteration appears to have followed the twin bands, giving the feldspar a striped appearance. In the microcline alteration has been bunchy. The feldspar showing the least alteration is untwinned, but is traversed by parallel ellipsoidal strain cracks, giving rise to a "perthitic" like appearance.

Associated with some of the fresher feldspars are numerous needle-like inclusions which appear much like rutile needles commonly found in quartz.

Another peculiar feature is where four highly altered, rounded feldspars are surrounded by a rim of slightly undulatory extinguishing quartz.

A flake of biotite surrounded by a rim of chlorite, a few grains of apatite and slightly undulatory extinguishing quartz, make up the remainder of the thin section.

The rock has evidently suffered some movement after consolidation, as cracks cross the thin section, passing through quartz and feldspars without any offsetting.

Slide number	C-26
Name	Microgneiss
Locality	East end of lake No.1, Plage I.

Macroscopic

Hand specimens similar to those described under C-4 and C-17.

Microscopic

Feldspars appear to be of two kinds: one highly altered passing mostly to sericite; the other unaltered and showing in most cases undulatory extinction. Small pieces show a crude grid-iron structure and perthitic intergrowth.

Quartz also appears to be of two periods: an early one cracked and showing undulatory extinction, and a later one of vein type showing uniform extinction.

Pale green chlorite with which is associated magnetite or ilmenite occurs marginal to the feldspars or filling cracks.

Murky, rounded grains of titanite and apatite are present.

The rock has suffered some crushing as the feldspars and quartz are cracked.

Slide number C-27
Name Granitic gneiss
Locality West shore of lake No.3. Plate I.

Macroscopic

A fine-grained somewhat micaceous rock, traversed by seamlets of green epidote.

Microscopic

A fine-grained, equitextured rock, made up chiefly of feldspar and quartz. Many of the feldspars are clouded by alteration products, some are fresh, some finely twinned and some untwinned. The quartz shows both undulatory and uniform extinction.

Bright, deep green chlorite, with which is associated magnetite or ilmenite?, is scattered through the thin section.

Apatite and titanite grains are common.

The most noticeable feature is that of a 2 mm. band of well-crystallized green epidote cutting through the thin section.

Slide number C-30.1
Name Granite
Locality Shore of lake No.7. Plate I.

Macroscopic

Practically identical with that described under C-24B.

Microscopic

Some of the feldspars, determined as oligoclase, show excellent albite and pericline twinning.

There is also an excellent example of biotite passing to chlorite.

Slide number C-30.5
Name Gneiss showing bands of feldspar
Locality North shore of lake No.7. Plate I.

Macroscopic

A dark, poorly foliated rock, through which pass bands

of pink feldspar.

Microscopic

Feldspars, both twinned and untwinned, occur as somewhat fractured "phenocrysts". One feldspar present shows Carlsbad and albite twinning. Alteration has been mostly to sericite, and is most noticeable along cleavage planes.

The groundmass is made up largely of greenish brown, primary biotite, showing undulatory extinction and often surrounded by a rim of chlorite and in places altered to epidote?.

Primary quartz is present in highly sutured and undulatory extinguishing masses, while secondary quartz is present as an aggregate of small crystals filling the interstitial spaces. There also appears to be a third quartz.

Apatite grains, apparently commonly oriented, are fairly abundant.

Zircon is present in the biotite, one grain showing an excellent pleochroic halo.

Slide number	C-31
Name	Metamorphosed granite
Locality	East end of Florence lake. Plate I.

Macroscopic

On the fresh surface appears as a coarsely crystalline biotite-rich granite.

Microscopic

A coarse holocrystalline granular rock made up of feldspar, quartz, biotite (hand specimen) and chlorite.

Feldspars present are altered and unaltered, being plagioclase, microcline, perthite and orthoclase, the former showing the greatest alteration. There appears to be feldspars of two periods, one the more basic, rounded and uniformly altered to sericite and kaolin; and a later one which shows practically no alteration other than strain cracks or fractures.

Quartz shows rounding, undulatory extinction and cracking.

A few highly altered biotite flakes, going over to chlorite and iron oxide, along with a few grains of apatite, make up the remainder of the thin section.

Slide number C-32.1
Name Granite
Locality East end of Bryant lake. Plate I

Macroscopic

A medium grained equitextured rock.

Microscopic

Feldspars are orthoclase and acid plagioclase. Many of the feldspars that are weathered show a distinct rounding. These also show fine twinning and alteration to sericite and muscovite, one piece showing a crude zonal weathering.

Quartz and feldspar are present in about equal amounts, the quartz showing considerable undulatory extinction.

Biotite, many pieces passing to chlorite, shows rounded zircon grains surrounded by pleochroic halos. A few small flakes of muscovite and grains of pyrite make up the remainder of the slide.

Slide number C-32.5
Name Biotite granite
Locality East end of Wylie lake at portage to
lake No.10. Plate I.

Macroscopic

A dark, coarsely crystalline rock, made up of a dull, brick-red feldspar, a pink feldspar, quartz and biotite.

Microscopic

Feldspar and quartz are present in about equal amounts.

The feldspars are untwinned or very finely twinned, and in most cases are clouded or spotted by alteration products, mainly sericite. Many of them show cleavage planes. One feldspar is as basic as andesine.

Quartz is present in relatively large, cracked, undulatory extinguishing masses.

Dark brown and dark green biotite appear to fill in between the feldspar and quartz members.

Rounded and roughly hexagonal bounded, commonly oriented, apatite crystals are common.

In addition, there are several rounded grains of zircon; pyrite and magnetite.

Slide number	C-33.4
Name	Biotite granite
Locality	East end of Burstall lake. Plate I.

Macroscopic

Similar to C-32.5, being, however, a little finer grained.

Microscopic

Feldspars show slight uniform alteration and are apparently of an acid variety. Where not altered they show fine albite twinning. There is a greater percentage of feldspar and a corresponding decrease in quartz as compared to slide C-32.5.

Quartz shows shadowy extinction and regular margins.

Pale green pleochroic biotite is somewhat more plentiful than in slide number C-32.5.

Epidote occurs in bunches and marginal to the biotite.

Apatite, pyrite and magnetite are sparingly present.

Slide number	C-34.4
Name	Metamorphosed arkose
Locality	Northwest corner of Wylie lake. Plate I.

Macroscopic

A dark, reddish, fine-grained rock.

Microscopic

Feldspars range in size from sub-microscopic to pieces measuring 3.2 x 1.2 mm., which gives the thin section a somewhat porphyritic appearance. These pieces occur as finely twinned grains in a groundmass of fragmental feldspars and chlorite. Alteration of feldspars is greatest in the central portions.

Chlorite, with which is associated iron oxides, fills the interstitial spaces around the feldspar grains and imparts a banded appearance to the slide. Chlorite also fills in along cleavage planes of the feldspars.

Apatite grains are present but not abundant.

Slide number C-34.6
Name Metamorphosed sediment
Locality West side of Wylie lake. Plate I.

Macroscopic

On the fresh surface appears as a salmon colored rock composed largely of brick red feldspar, small seams of biotite and quartz.

Microscopic

In thin section the rock has a porphyritic appearance, the larger grains being mostly of orthoclase clouded by a thin film of alteration products.

The groundmass is made up of fragmental feldspars, many of which are finely twinned, and clear granular uniform extinguishing quartz. In places chlorite, biotite and muscovite twist among the groundmass and around the larger grains. In one or two places this micaceous material fills cracks in the larger fractured grains.

Apatite grains and magnetite appear associated with the biotite.

Slide number C-35.1
Name Granite
Locality Northwest of north end of lake No.3.
Plate I.

Macroscopic

A pink, medium textured granite, with a small amount of biotite.

Microscopic

Rock is essentially made up of feldspar and quartz, along with the accessory and secondary minerals chlorite, epidote, iron oxides and zircon.

Feldspars occur both twinned and untwinned. Twinned feldspars occur both fresh and altered, and the untwinned, similarly,

occur fresh and altered. Fine albite and microcline twinning are the most common. The alteration products of the altered feldspars are calcite and sericite.

Two quartzes are evident, one as suture-edged masses which show undulatory extinction, and a later granular form showing uniform extinction.

A small amount of biotite, going over to chlorite and epidote, is present around the feldspars and as infilling between the other minerals.

The accessories iron oxide, apatite and zircon are sparingly present.

The rock appears to have suffered strain, but little or no crushing.

Slide number	C-35.3
Name	Metamorphosed siltstone
Locality	Half mile east of south end of lake No.3. Plate I.

Macroscopic

A very fine grained, dark purple rock, which on the weathered surface shows irregular "veinlets" of a pale green (chloritic) material.

Microscopic

Essentially made up of quartz (fragments), chlorite, sericite, magnetite and the accessory mineral feldspar.

The quartz occurs as minute fragments. The chlorite and sericite show a sub-parallel arrangement, probably following old bedding planes.

Magnetite is abundant, as irregular and square, bounded grains.

A small amount of carbonate is present.

The rock was apparently an argillaceous sandstone or siltstone, the clay material on alteration being converted to sericite.

Slide number	C-35.4
Name	Quartzite
Locality	Quarter mile east of south end lake No.3. Plate I.

Macroscopic

A fine-grained, reddish, silicious rock, which on the weathered surface shows a faint banding.

Microscopic

The rock is composed of irregular fragments of quartz and feldspar, around and through which is later uniformly extinguishing quartz, micaceous material, biotite, calcite, pieces of magnetite and feathery hematite.

The rock is decidedly sedimentary in character, probably a consolidated impure sand.

Slide number	C-36.1
Name	Granite
Locality	Big point, lake Athabaska. Plate I.

Macroscopic

A coarse grey biotite granite.

Microscopic

Made up of feldspar, quartz and biotite, along with the alteration products chlorite, epidote, muscovite, sericite and accessory mineral zircon.

The feldspars, ranging from orthoclase to oligoclase, are for the most part clouded and pitted by alteration. A few, however, are nearly fresh. Alteration has been chiefly to sericite, and epidote., An abnormal feature in this granite is the presence of rounded, well-altered feldspar grains enclosed within a later and much fresher feldspar. Carlsbad and albite twinning, separately and combined, are present in many of the feldspars.

The quartz present is of two periods, an earlier fractured one showing marked undulatory extinction, and a later vein type filling cracks within the feldspar and quartz. A certain amount of recrystallization of the quartz has taken place along some of the cracks.

Highly altered and murky biotite is relatively abundant. In many places it may be seen going over to chlorite and epidote. Some of the biotite shows marked shadowy extinction and bent flakes. There are a few flakes of muscovite.

A few grains of zircon occur with the feldspar and biotite; in the biotite they show pleochroic halos.

That the rock has suffered considerable dynamic metamorphism is shown by the fractured and strained quartz, the irregular cracked and fractured feldspar, the marked bending and twisting of the micaceous flakes.

Slide number	C-37
Name	Metamorphosed sediment
Locality	Big point, lake Athabaska. Plate I.

Macroscopic

A blotchy red (feldspar), coarsely crystalline, granitic-like biotite rock.

Microscopic

Feldspars are somewhat rounded and all highly uniformly altered, going over to calcite, sericite and a small amount of iron oxide.

Quartz present is cracked, fractured, contains many inclusions and shows marked undulatory extinction. Some recrystallization seems to have taken place along some of the cracks.

The alteration of biotite to chlorite and iron oxide is remarkably well shown. The twisted and contorted biotite cleavage may still be seen throughout parts of the chlorite. Micaceous material (largely chlorite) fills cracks in the fractured minerals.

Occasional grains of zircon present.

This rock has suffered considerable dynamic metamorphism.

Slide number	C-38.2
Name	Metamorphosed sediment
Locality	Half mile north of Big point. Plate I.

Macroscopic

Is similar to C-34.6, being a little coarser and the biotite arranged roughly in parallel seams. On one side the specimen is much finer grained and darker in color.

Microscopic

The coarse and fine phase mentioned above is seen in thin section.

The finer portion is made up of angular feldspar fragments (a few of these have been broken off of feldspars of the coarser phase), surrounded by a groundmass of small feldspar fragments and an indefinite ferruginous, micaceous material. Grains of zircon present. The whole has a brecciated appearance.

The coarse phase is made up largely of feldspars and quartz. The feldspars (oligoclase, microcline, microperthite and orthoclase) appear altered, the majority of these showing some rounding; where unaltered they show a little rounding, but are for the most part angular.

Quartz appears in the coarser phase in relatively large undulatory extinguishing masses, occasionally enclosing rounded feldspar.

Murky green chlorite with associated magnetite fills cracks and intergranular spaces.

That the rock has suffered considerable crushing is shown by the marked undulatory extinguishing and crushed quartz, and by the cracked and strained feldspar.

Slide number	C-42.
Name	Feldspar biotite gneiss
Locality	From point in Big bay. Plate I.

Macroscopic

A dark, in outcrop, red feldspar, biotite, gneiss.

Microscopic

Made up of feldspar, biotite, chlorite, hornblende,

diopside and accessories or alteration products, sericite, zircon, apatite and epidote.

Feldspars, orthoclase, albite and oligoclase, occur in altered, somewhat rounded crystals. Alteration being to sericite, epidote and a small amount of calcite.

The feldspars are surrounded by brown and dark green biotite and chlorite, the biotite having a very peculiar birefringence. Associated with the biotite occurs idiomorphic crystals of diopside?, some hornblende and iron oxide.

Epidote is common, scattered throughout the feldspars and associated with the biotite.

Rounded zircon and apatite grains are scattered throughout the slide.

The peculiar nature and relations of the minerals, along with the texture, suggests that the rock has resulted from a highly metamorphosed sediment.

Slide number	C-44
Name	Slate
Locality	Shore of lake Athabaska, five miles north of Sand point. Plate I.

Macroscopic

A bluish green, fine grained slate.

Microscopic

The rock consists of small fragments of quartz and feldspar, around which is shredded micaceous material, chiefly chlorite and remnants of biotite commonly aligned. Numerous grains and irregular patches of magnetite are scattered throughout the thin section.

Slide number	C-45
Name	Fine grained quartzite
Locality	On shore, four miles north of Sand point. Plate I.

Macroscopic

A silicious, fine textured, light purplish quartzite.

Traces of bedding may be seen on the weathered surface.

Microscopic

Texture similar to that described under slide C-44. In this slide (C-45), there is less micaceous material, more quartz and sufficient hematite to impart the purplish color mentioned above. Numerous small grains of pyrite also present.

Slide number C-46
Name Metamorphosed argillaceous sandstone
Locality On shore, 3.5 miles north of Sand point.
Plate I.

Macroscopic

A buff-colored, arkosic-like rock, showing patches and streaks of limonitic material.

Microscopic

Rounded and angular grains of quartz, showing marked undulatory extinction and a sub-parallel arrangement. Another quartz showing marked sutured borders and undulatory extinction fills in between many of the grains (probably a recrystallized granular quartz).

There are patches of magnetite, around the margins of which appear blood-red, slightly pleochroic flakes of hematite.

The remainder of the thin section is made up largely of highly polarizing micaceous material, showing a sub-parallel arrangement, being bent and twisted around the quartz and feldspar grains.

A few small rounded grains of apatite and titanite are present.

The rock was probably an impure sandstone.

Slide number C-48
Name Arkosic gneiss
Locality Shore of lake Athabaska 2 miles north of Sand point. Plate I.

Macroscopic

A green gneissic rock in which occur "pebbles" of pink feldspar and irregular pieces of old slaty or shaly material.

Microscopic

The rock is made up of fragments of shale or slate (in all probability derived from the underlying Tazin series), calcite, feldspar, quartz and micaceous material.

The slate or shale fragments are almost isotropic, being coated with a film of ferruginous material and considerable sericite.

Calcite is abundant and apparently secondary, replacing other minerals and infilling cracks.

The feldspar is albite? which shows little alteration.

Quartz is variable; some of it has been granulated, some shows shadowy extinction and some is of vein type.

Chlorite, apatite and iron oxide are scattered throughout the rock. The chlorite is arranged in sub-parallel stringers and is largely responsible for the gneissic character.

Slide number C-50
Name Injection gneiss
Locality Two and a half miles southwest from bottom of Fishery bay, lake Athabakka. Plate I.

Macroscopic

Over fifty per cent of the rock is made up of weathered and altered feldspar crystals, the remainder consisting of quartz, sericite and chlorite.

The quartz is very clear, granular and has uniform, or in some cases, very slight undulatory extinction. This quartz is later and has been injected lit-par-lit into what was probably a loosely consolidated arkosic rock.

Chlorite, for the most part, is marginal to the feldspars and was probably formed contemporaneously with the injection of the quartz.

In addition a small amount of hematite and an occasional grain of apatite are present.

Slide number C-51
Name Intrusive gneiss
Locality Same as that of slide C-50. Plate I.

Macroscopic

Macroscopic is practically the same as that of C-50. In this specimen there is a greater percentage of micaceous material and less alignment of the rock-forming minerals. Grains of pyrite appear on fresh surfaces.

Microscopic

Feldspars are rounded, altered and decayed. Quartz has sutured margins and high undulatory extinction. A very conspicuous mineral is pale brown pleochroic biotite passing in many cases to chlorite. One place shows a fresh biotite flake surrounded by a margin of chloritized biotite which encloses grains of apatite.

Rounded grains of apatite and irregular patches of magnetite are abundant.

The thin section shows a well developed lamination.

Slide number C-52
Name Microgneiss
Locality Same as that for C-50 and C-51. Plate I.

Macroscopic

A fine grained silicious rock of a bright pink color.

Microscopic

The gneiss is made up of decayed and somewhat ragged-edged feldspars, which show in many cases a remarkable development of strain cracks, and quartz cemented by a later quartz.

The original quartz areas are, in many cases, cracked and show undulatory extinction, the cracks being healed by the later quartz.

Hematite is scattered somewhat regularly over the section.

The rock in this section possesses a distinct banding, due to the somewhat parallel injection of quartz. This banding is not obvious in the hand specimen.

Slide number	C-53
Name	Microgneiss
Locality	Same as that of C-50, C-51 and C-52. Plate I.

Macroscopic

In general appearance is similar to that described under C-52. This one, however, being a little darker in color and showing a greater tendency to banding, due to the greater amount of chlorite.

Microscopic

Practically the same as that described under C-52. The feldspar (some of which may be recognized as microcline) shows more alteration and in addition chlorite and sericite are present; otherwise the mineralogical relations and composition are the same.

Slide number	C-54
Name	Chlorite schist
Locality	Same as that of C-52 and C-53. Plate I.

Macroscopic

Is very similar to that described under C-6 and C-50. This, however, shows a greater schistose and foliated structure, but fewer and smaller augens. The rock is greenish in color and on fresh surfaces shows the characteristic sheen of chlorite schists.

Microscopic

The chief constituent is chlorite, which shows a subparallel arrangement. There appear "knots" which are probably the remains of feldspars, now altered to epidote?, sericite and calcite. The more chloritic phases are bent around these "knots".

Irregular and scattered pieces of magnetite are associated with the chlorite. Hematite is thinly scattered over the section, the greater part being within the altered feldspathic areas.

Later seamlets of calcite cut across the rock.

Slide number	C-55
Name	Schist
Locality	Same as that of slide C-52, C-53 and C-54. Plate I.

Macroscopic

Is a laminated, cleavable rock of a dirty grey color, in which no definite mineral determination may be made in the hand specimen. When moistened the odor of kaolin is quite pronounced.

Microscopic

The rock consists of unaltered and highly altered feldspar, the latter having gone over to calcite, epidote, sericite and kaolinite.

Undulatory extinguishing and granular, uniform extinguishing quartz make up the remainder of the thin section.

In this thin section there is a much greater percentage of quartz than in slide C-54. The rock probably represents a much more absorbed schist than that of C-54.

Slide number	C-56
Name	Arkose
Locality	Same as that for C-54 and C-55. Plate I.

Macroscopic

On the polished surface the texture and mineralogical composition of this rock is remarkably well shown. There are reddish and dull grey altered feldspar grains cemented by clear transparent quartz.

The dull grey patches probably represent highly kaolinized feldspars as the odor of kaolin is quite pronounced when the rock is moistened.

Microscopic

Kaolinized feldspar masses make up the major part of the rock. A small amount of untwinned and lattice twinned feldspar showing shadowy extinction but no crushing is also present. Around these feldspars occur sericite and granular uniform extinguishing quartz which is obviously later and of the vein type.

Slide number C-57
Name Hematite schist
Locality North shore of Lake Athabaska. Plate I.

Macroscopic

A red colored, altered, fractured rock. A piece of this when treated with hydrochloric acid and the iron oxide thus removed is very similar in appearance to C-55.

Microscopic

In thin section the rock is seen to consist of highly altered iron stained feldspar, around and through which is badly crushed and strained quartz which shows marked sutured borders and intergrowth. A peculiar feature of the quartz is the presence of numerous sub-parallel lines of minute inclusion. Seamlets of later quartz traverse the thin section.

A grain of fractured apatite is very conspicuous.

Slide number C-58
Name Chlorite magnetite gneiss
Locality Specimen from gneissic zone between the
Tazin series and massive granite gneiss.
North shore Lake Athabaska. Plate I.

Macroscopic

A fine, evenly grained, crystalline, dark rock.

Microscopic

Feldspar for the most part is untwinned and unstrained, and more or less uniformly altered to sericite.

Quartz shows marked undulatory extinction.

The most noticeable feature is the abundance of pleochroic green chlorite, with which is associated numerous and relatively large masses of magnetite, many of which show a thin film of hematite.

Several elongated crystals of apatite, some of which are cracked, and areas of sphene are present.

There is a rough parallelism of the mineral constituents.

Slide number	C-59
Name	Impure ferruginous quartzite
Locality	North shore lake Athabaska. Plate I.

Macroscopic

A fine grained, purplish tinted rock, occurring in steeply dipping beds.

Microscopic

Is clearly a fragmental rock, possibly a quartz, feldspar mud. Quartz shows undulatory extinction and sutured margins (probably a recrystallized phase). Cracked grains of quartz healed by iron oxide are common.

A few grains of fresh feldspar present, but the majority seems to have gone over to calcite, sericite and iron oxide.

An occasional flake of mica present.

Slide number	C-60
Name	Quartz-rich arkose
Locality	North shore lake Athabaska. Plate I.

Macroscopic

A cream-colored, fine grained rock.

Microscopic

Fresh but cracked grains of feldspar are abundant. The greater part of the rock is made up of grains of undulatory extinguishing quartz. These two constituents are cemented by kaolin and micaceous material.

Irregular pieces of magnetite, some of which are altering to hematite, are scattered throughout the thin section.

The rock shows a sub-parallel arrangement of the minerals. The undulatory extinction, so noticeable in the quartz, was probably derived prior to its incorporation in this rock.

Slide number	C-61
Name	Silicious slate
Locality	One hundred yards southwest along shore from C-60. Plate I.

Macroscopic

The hand specimen shows the contact between a red quartzite phase and a fine-grained silicious slate phase of two beds of the Taxan series.

On the polished surface this contact is very well shown.

Microscopic

The thin section is of the fine grained, slaty phase.

Under the high power the slate is seen to be made up of small fragments of undulatory extinguishing quartz, among which anastomoses an indefinite micaceous material. Calcite, magnetite and a thin film hematite are irregularly scattered over the slide.

Slide number	C-62
Name	Silicious arkose
Locality	Same as that of C-61, only taken one hundred feet inland from shore of lake. Plate I.

Macroscopic

A pink colored, somewhat granular rock with poorly developed fracture planes.

Microscopic

Is distinctly a fragmental sedimentary rock. Rounded grains of feldspar and quartz make up the greater part of the thin section.

The feldspars vary considerably, some are fresh, some weathered, some cracked, others not, many finely twinned, some untwinned, but all more or less rounded.

Quartz is present as elongated and rounded grains which show marked undulatory extinction.

The feldspar and quartz grains are surrounded by calcite, kaolinite and an indefinite dark material which is noticeably stained with iron oxide.

Slide number C-63
Name Biotite chlorite (magnetite) gneiss
Locality Same as that of C-62. Plate I.

Macroscopic

A fine grained, evenly crystalline rock, with a few irregular red patches. Specimen similar to that of C-58.

Microscopic

The rock is made up of irregular, broken and unbroken, weathered and unweathered feldspars; suture bordered and strained quartz.

Brown pleochroic biotite may be seen going over to green pleochroic chlorite, and throughout the latter are irregular patches of magnetite.

Numerous rounded grains of apatite and small grains of titanite (latter very abundant) are scattered throughout the rock.

Calcite and sericite are present, being associated mainly with the altered feldspars.

The thin section has a distinct gneissic character, owing largely to the parallel arrangement of the micaceous material.

Slide number C-64
Name Arkose breccia
Locality Same vicinity as that of C-62. Plate I.

Macroscopic

A granular textured rock of a pink and green tinge, due

to areas of reddish feldspar and greenish chlorite. Specimen shows an angular piece of chloritic slate material.

Microscopic

The rock is seen to be clastic in character, made up of rounded and angular grains of fresh and altered feldspar.

Quartz showing undulatory extinction is common as rounded and shattered grains and as groundmass.

Later calcite and micaceous material is present around the quartz and feldspar.

Slide number	C-65
Name	Slate
Locality	North shore lake Athabaska. Plate I.

Macroscopic

A fine grained, light purple colored slate, cut by seamlets of quartz.

Microscopic

A very fine textured rock, made up of feldspar fragments and patches of a pale green material. Under high magnification these green patches appear as fine aggregates, rather than one species. They are probably pieces of slaty material stained with ferrous iron.

Short shreds of micaceous material and grains of pyrite are scattered irregularly throughout the rock.

Slide number	C-66
Name	Crossbedded sandstone (Athabaska)
Locality	North shore of lake Athabaska north of Sand point. Plate I.

Macroscopic

A red, relatively fine-grained sandstone, showing cross-bedding on the weathered surface. This phase of the Athabaska sandstone is closely associated with the conglomeritic phase.

Microscopic

Sandstone is made up of two quartzes, micaceous (sericite) material and a fine mud material which is now stained red by iron oxide.

Rounded quartz grains, marked off by minute inclusions or dust particles, are inclosed in a later quartz which has grown around and in optical continuity with the original grains. This later quartz is also scattered in bunches throughout the sandstone.

Cementation of the original rounded and angular grains has been brought about by later quartz and micaceous material. This latter material, where in contact with or in the vicinity of quartz showing undulatory extinction, is invariably bent or twisted around this quartz. Where associated with the later uniform extinguishing quartz, the shredding of the sericitic material is more uniform.

Slide number	C-67
Name	Granite
Locality	Four miles south of where the outlet of Flett lake joins the Riviere des Rochers. Plate II.

Macroscopic

A fine grained, pink, granitoid textured rock.

Microscopic

The rock is made up essentially of feldspar and quartz, the secondary minerals iron oxide and chlorite, and the accessory minerals magnetite and garnet.

The feldspars, all fairly fresh, are orthoclase, microcline, microperthite and micropegmatite. One piece shows pericline twinning, microperthite and micropegmatite structure.

The micropegmatite and microperthite show no alteration.

Quartz occurs in clear, smooth margined masses that show very slight undulatory extinction.

Hematite, a little chlorite, and magnetite are scattered irregularly throughout the rock; hematite occasionally present as a rim around the magnetite. There are a few grains of cracked garnet. A rim of chlorite surrounds the garnet and also heals the fractures.

Slide number	C-68
Name	Basic inclusion (gabbro)
Locality	From basic areas within the red granite described under slide C-67; four miles south of where outlet of Flett lake joins the Riviere des Rochers. Plate II.

Macroscopic

A dark, poorly foliated basic rock.

Microscopic

An equitextured, holocrystalline rock made up of feldspar, hornblende, pyroxene, olivene, magnetite and the secondary minerals magnetite (ilmenite?), antigorite, along with the accessory mineral apatite.

Feldspars are uniformly distributed, are basic (labradorite), unaltered, but in many cases cracked, the cracks being filled with iron oxide.

Hornblende and pyroxene (augite) are abundant, being present in the proportions of about 3:1.

Olivene occurs in somewhat rounded masses, around and through which is magnetite or ilmenite?. Around some pieces of olivene there is a brilliant green, slightly pleochroic mineral, probably antigorite.

Primary magnetite and apatite are scattered throughout the thin section.

The rock appears to have suffered little alteration other than crushing, as many of the minerals, chiefly the feldspars, are badly cracked.

Slide number	C-72
Name	Basic inclusion (gabbro).
Locality	East of Rocher river. Plate II.

Macroscopic

An even textured, somewhat fine grained, dark rock, macroscopically showing abundant hornblende.

Microscopic

A holocrystalline rock showing a mosaic of feldspar,

hornblende, pyroxene (augite), alteration products, magnetite, apatite and a small amount of calcite and later quartz.

The feldspars range from microcline to labradorite and show a streaky weathering or alteration.

Green hornblende appears fresh and slightly altered. Alteration being to chlorite, along cracks and margins.

The pyroxene (augite) for the most part is altered to a fibrous aggregate, probably chlorite, which in turn appears to have altered to uralite.

Magnetite, pyrite and apatite, along with a few seams of calcite and quartz, make up the remainder of the slide.

Slide number	C-73
Name	Metamorphosed arkose
Locality	Rochers river. Plate II.

Macroscopic

A grey crystalline rock, traversed by small seams of micaceous material.

Microscopic

A rock somewhat cataclastic in character, made up of fairly fresh, twinned and untwinned, fractured, granulated and slightly undulatory extinguishing feldspar. As an interstitial filling have chlorite and biotite along with abundant apatite.

The twinned feldspar appears to be microcline and the untwinned, orthoclase.

The feldspar grains are separated by and cracks filled with granulated material, biotite?, chlorite and secondary quartz.

Rounded apatite grains are abundant.

Small amount of calcite present, healing some of the cracks within the feldspars.

Slide number	C-76
Name	Metamorphosed sediment
Locality	North shore of Flett lake. Plate I.

Macroscopic

A grey, somewhat schisted, altered feldspar rock.

Microscopic

Rock is made up of altered and unaltered, finely twinned and untwinned feldspars, quartz and micaceous material.

Many of the feldspars are highly altered, alteration being to kaolin and sericite. The unaltered ones are finely twinned microcline and untwinned orthoclase.

Quartz appears to be of two generations, the first now strained, cracked and showing a certain amount of granulation and recrystallization; the later one showing smooth margins and uniform extinction.

Biotite and chlorite, the former in some cases altering to the latter, along with muscovite, are scattered throughout the rock.

The schisty character seen in the hand specimen is not obvious in thin section.

Slide number	C-79
Name	Hornblendite
Locality	South shore of Flett lake. Plate I

Macroscopic

A dark green, massive, somewhat foliated amphibolite rock.

Microscopic

Made up entirely of pale and dark green hornblende. Some alteration has started, the hornblende beginning to go over to fibrous chlorite. Basal sections show highest refringence.

Small amounts of iron oxides are scattered sparingly throughout the rock.

Slide number C-82
Name Highly metamorphosed arkose?
Locality Rochers river. Plate II

Macroscopic

A granitic textured rock, made up of white and red feldspar, quartz and biotite, the latter showing some alignment.

Microscopic

Rock is made up of quartz and feldspar masses, separated by finer interstitial material.

The feldspars all show some alteration, some being highly altered, iron stained and showing rounded outlines. Are untwinned except for a few which show a very fine twinning. About 50 per cent of the feldspar present is microperthite, the remainder being largely orthoclase.

Quartz showing slight undulatory extinction, occurs in large masses and often encloses rounded altered feldspars.

Flakes of muscovite and biotite (with zircon), the latter altering to chlorite; along with fragmental interstitial quartz and feldspar, fills in between the larger quartz and feldspar areas.

The rock has suffered some crushing, as both the feldspar and quartz are traversed by numerous cracks, these being healed by micaceous material or iron oxide.

Slide number C-83
Name Absorbed arkose?
Locality Rochers river. Plate II.

Macroscopic

A grey, crystalline, feldspar-rich rock which breaks readily along the margins of the feldspars.

Microscopic

The rock is made up almost entirely of feldspar (microperthite, microcline, oligoclase?) and associated alteration products.

The feldspars all show some alteration, some being somewhat more altered than others, these latter also showing considerable

rounding. They are untwinned except for a few which show a very fine twinning.

Quartz is sparingly present in isolated, smooth-margined grains or areas showing practically uniform extinction.

The most abundant alteration product is sericite, with which is associated small amounts of pale green pleochroic chlorite.

Slide number C-84
Name Granite (gneissic)
Locality Rosher river. Plate II

Macroscopic

A reddish colored, clastic, granitic textured rock.

Microscopic

Made up of two feldspars, quartz and micaceous material.

One feldspar occurs as rounded, well-altered grains, alteration being to sericite and ferruginous material. This feldspar is enclosed in a much fresher feldspar (microperthite, microcline?, orthoclase). The margins between these feldspars are smooth, or are often separated by a narrow zone of fragmental material. A few grains show a fine albite twinning.

Quartz, where in contact with other minerals, shows a smooth margin, slight undulatory extinction, and acts as granular interstitial matter. The quartz appears to be later.

Small patches or flakes of biotite and chlorite, with associated magnetite, are scattered over the thin section.

A few rounded zircons enclosed in biotite show excellent pleochroic halos.

Both the feldspar and quartz are fractured, showing that the rock has suffered crushing. The cracks where healed are filled with iron oxide or micaceous (largely chlorite) material.

While the rock now appears to be a granite, it has many features that are abnormal to granites. It may possibly represent a highly absorbed sediment and many of the features support this view.

Slide number C-84.1
Name Granitic gneiss
Locality Rocher river. Plate II

Macroscopic

A grey colored quartz feldspar rock, closely associated with specimen C-84.

Microscopic

The greater part of the rock is altered feldspar. Alteration both blotchy and uniform, clouds the feldspars and is most noticeable in those showing a rounded outline. Alteration has been to sericite, calcite and fine ferruginous material. Most of the feldspars are untwinned, with a few showing fine albite twinning. Smaller feldspars that are enclosed in untwinned ones show the broad irregular twinning characteristic of the more basic types.

Micaceous material, biotite, muscovite and chlorite, along with other fragmental material, occurs marginal to and filling the interstitial spaces between the feldspars.

Quartz, showing only slight undulatory extinction, heals cracks in the feldspars and acts as interstitial filling.

This rock, like C-84, appears to have been derived from a sediment, one that was fractured and then recemented.

Slide number C-87
Name Granite!
Locality Rochers river. Plate II

Macroscopic

A grey, fairly coarsely crystalline, grey, quartz feldspar rock showing bunches or blotches of biotite.

Microscopic

The feldspars, microperthite, microcline and albite vary in degree of alteration. Alteration is commonly in bands, streaks or uniform across the feldspar. While many show sharp irregular margins, many smaller pieces of rounded and smooth margined feldspar occur enclosed within the other minerals.

Quartz shows slight shadowy extinction and in places granulation and cracking.

Micaceous material, sericite, muscovite, biotite and chlorite?, are present within the feldspar, marginal to, and locally bunched. Biotite is commonly altered.

The rock has suffered crushing, as shown by the cracked nature and offsetting along cleavage lines in the feldspars.

Slide number C-93
Name Altered granite
Locality Powder creek. Plate II

Macroscopic

A medium textured, grey colored rock, made up of altered feldspars, thin irregular seams of biotite and an opalescent (blue) quartz.

Microscopic

(Thin section is considerably above normal thickness).

Feldspars are highly altered, going over to sericite, kaolinite and ferruginous material.

Quartz shows high polarization colors and numerous lines and patches of inclusion.

Murky, micaceous material occurs through the feldspars.

The margins of many of the mineral constituents are indefinite. There is also a considerable variation in the grain size.

Slide number C-94
Name Syenite?
Locality Powder creek. Plate II

Macroscopic

A pink, fine-grained, crystalline, granitic rock.

Microscopic

Rock made up of feldspar, quartz, biotite, associated alteration products and accessory titanite.

Slide number	C-99
Name	Syenite
Locality	Powder creek. Plate II

Macroscopic

A feldspar-rich rock in which biotite occurs in "bunches".

Microscopic

Composed almost entirely of acid feldspars, orthoclase, albite and oligoclase?. Feldspars are relatively fresh, being only slightly clouded by fine alteration products.

Quartz is sparingly present in slightly cracked, uniformly extinguishing pieces.

Brown biotite, showing numerous dark halos; halos having center of zircon, are pleochroic.

Slide number	C-102
Name	Quartz, garnet, syenite
Locality	Slave river. Plate II

Macroscopic

A garnetiferous, grey feldspar-rich rock.

Microscopic

Is essentially a feldspar rock. There appears an altered, smooth-margined feldspar enclosed or cemented by a fresher, probably later feldspar.

The fresh feldspars, albite, micropegmatite and microperthite, the latter being the most abundant, make up the greater part of the thin section. In some places the feldspars are separated by a rim of fine epidote, which may also be traced into the adjacent cracks. Some of the microperthite shows a series or network of fine cracks.

There are a few grains of rounded, cracked garnet, with which is associated microperthite and feldspar showing graphic intergrowth.

Quartz is sparingly present. In it are numerous short, very fine needles of rutile. Part of the quartz appears to have been later.

Slide number C-104
Name Basic inclusion
Locality East of Slave river. Plate II

Macroscopic

A dark, crystalline, biotite feldspar rock.

Microscopic

Rock is made up of feldspars, quartz, biotite, the alteration products sericite, kaolinite, and the accessory minerals titanite and zircon.

The feldspars (mostly albite) show fine albite twinning and in addition a few show Carlsbad twins. They are somewhat uniformly clouded by sericite and kaolinite.

Quartz is present in often rounded, practically uniform, extinguishing patches.

Pale brown and green pleochroic biotite is scattered over the slide, often having associated with it masses of magnetite leucoxene? and short needles of rutile?.

Rounded titanite and zircon grains are common, both within the biotite and feldspar, some showing a good pleochroic halo.

There is considerable variation in grain size. The feldspars and quartz are cracked, indicating crushing.

Slide number C-104.1
Name Grey granite
Locality East of Slave river, the same as for C-104.

Macroscopic

A grey, in places, coarsely crystalline feldspar, quartz, biotite rock.

Microscopic

The feldspars (microperthite, albite) show fine albite twinning and an occasional Carlsbad twin. Patchy sericitization and kaolinization of the feldspars is noticeable. There appears to be two feldspars, one altered and a later fresh, unaltered one which meets the altered feldspar with smooth rounded margins.

Slightly undulatory extinguishing quartz is present, associated with the altered feldspar.

Brown pleochroic biotite is fairly abundant and with it is associated masses of magnetite.

Fractured garnet is present in one part of the slide. Adjacent sides of the fractured pieces are seen to match. The cracks between the fractures are now filled with chlorite.

Titanite and zircon grains are present, both within the feldspar and biotite. The titanite often being surrounded by a rim of alteration products.

Cracking and fracturing along cleavage planes is common in the feldspar. A few of the more persistent cracks pass through quartz and feldspar.

Slide number	C-114
Name	Metamorphic arkose
Locality	La Butte creek. Plate II.

Macroscopic

A bright pink feldspar quartz rock. In outcrop this rock breaks along parallel planes from 2 to 3 inches apart.

Microscopic

This rock is composed of uniformly altered feldspar, into which has come clear, uniform extinguishing quartz. The alteration product clouding the feldspar is largely iron oxide (hematite).

A certain amount of granulation appears to have taken place along the margins of the feldspars. Chatter cracking is also common.

Slide number	C-119
Name	Biotite augen gneiss
Locality	La Butte creek. Plate II

Macroscopic

A dark foliated micaceous rock, in and through which occur fractured units of pink feldspar.

Microscopic

Feldspars occur as relatively fresh augens. For the most part the augens are untwinned, although one shows well defined albite twinning. One augen shows a Carlsbad twin and a bending of the cleavage planes.

Bent around these augens and showing a parallel arrangement occur flakes of green biotite.

Quartz appears to be of two periods, one showing undulatory extinguishing and cracked masses, and a later and more abundant quartz occurs throughout the micaceous areas, in clear, granular, uniform extinguishing grains.

Associated with the biotite, and occasionally with the feldspars, occur abundant titanite and apatite grains. The former in many cases are rimmed with alteration products.

Slide number	C-120
Name	"Porphyritic" biotite gneiss
Locality	Forks of La Butte creek. Plate II

Macroscopic

Similar to C-119, only showing less foliation and larger orthoclase "phenocrysts", one measuring 45 x 25 x 7 mm.

Microscopic

Most of the feldspars show smooth margins and alteration. Alteration has proceeded furthest in the central portions, sericite being the chief product. None of the feldspars appear absolutely fresh, although some have suffered a great deal more alteration than others. Many show Carlsbad twins, and some show albite twinning combined with Carlsbad.

Quartz appears to be of two periods, an earlier and more massive form showing undulatory extinction, and a later granular type which, along with biotite, fills many of the cracks and interstitial spaces.

Murky, green, twisted, biotite, in which occur abundant rounded and longitudinal apatite grains, titanite grains and magnetite, makes up the remainder of the thin section.

The slide, on the whole, shows a somewhat clastic texture.

Slide number	C-127
Name	Quartz schist
Locality	From island in Slave river south of Caribou island. Plate II.

Macroscopic

A grey, quartz, slightly schistose rock.

Microscopic

A distinctly banded, fine grained rock made up chiefly of fragmental quartz and feldspar into which has come later quartz, the quartz areas having their long dimensions parallel.

A few larger grains of feldspar (microperthite) are present, some of which are surrounded by a rim of micaceous material.

Green biotite is scattered through the fine grained material.

Slide number	C-129
Name	Granite
Locality	Slave river. Plate II

Macroscopic

A grey granitic textured rock, in which the ferromagnesian minerals tend to occur in bunches.

Microscopic

Feldspars occur as badly altered and relatively fresh, untwinned (except occasional Carlsbad twins) aggregates (microperthite), the latter showing more definite margins. Also highly altered granular feldspar fills many of the interstitial spaces. Sericite and a little calcite appear to be the chief alteration products.

The quartz present shows uniform extinction.

Highly fractured garnet is fairly plentiful, the fractures being filled with green micaceous material.

A few rounded apatite grains, an occasional titanite grain, a little iron oxide and calcite make up the remainder of the thin section.

Slide number C-132
Name Granite
Locality Slave river. Plate II

Macroscopic

A grey, medium textured granite.

Microscopic

(Thin section is considerably above normal thickness).

Rock is made up mostly of feldspar, along with quartz, micaceous material and alteration products.

Feldspars for the most part are highly altered and occur in rounded and granulated grains. Alteration has been chiefly to calcite, sericite and cloudy ferruginous material.

Quartz areas show marked undulatory extinction, sutured and granulated margins.

Green and murky chlorite, commonly associated with iron oxide, isscattered through the thin section.

Slide number C-138
Name Red sandstone (Athabaska)
Locality North shore of lake Athabaska. Plate I.

Macroscopic

A red sandstone showing parting planes.

Microscopic

Is made up of rounded and sub-angular quartz grains in a matrix of micaceous, fragmental quartz, and chalcedony material. The latter showing a dark cross when rotated under crossed nicols.

Many of the quartz grains show around them a growth of secondary quartz. Also many are bounded or marked off by a border of ferruginous material.

Cementation is by chalcedony, micaceous and ferruginous material. Throughout this cementing material are a few flakes of muscovite, biotite and remnant pieces of old slate or shale.

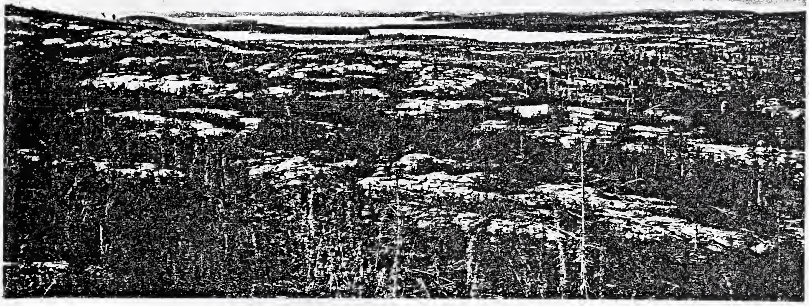


Fig.1. Wylie lake from portage from Florence lake.

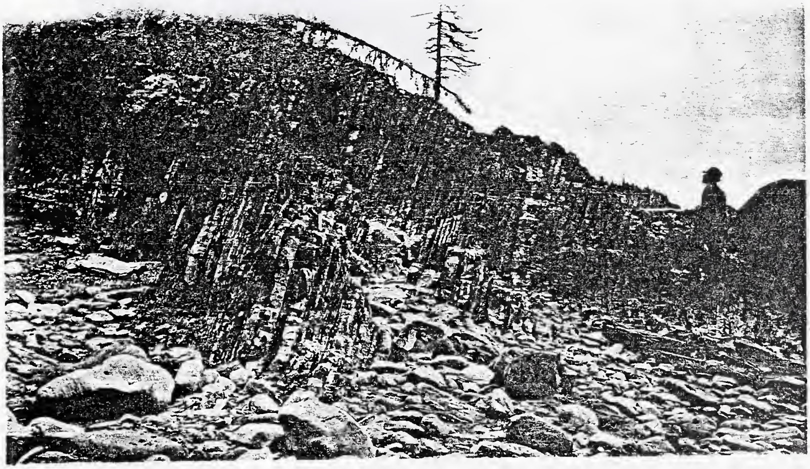


Fig.2. Tilted Tazin slates and quartzites along north shore of lake Athabaska, north of Sand point. Referred to on page 21.

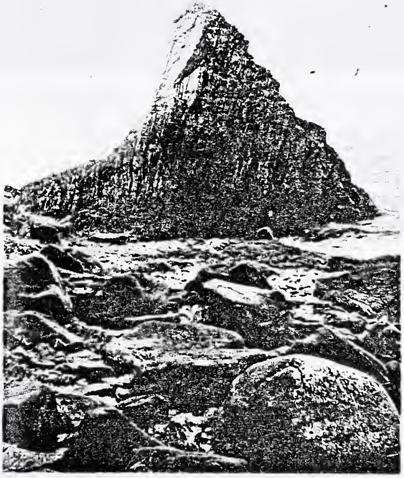


Fig.3. Chlorite schists of the Tazin series, forming headlands (exposure 15 feet high), north shore of lake Athabaska. Referred to on page 20.

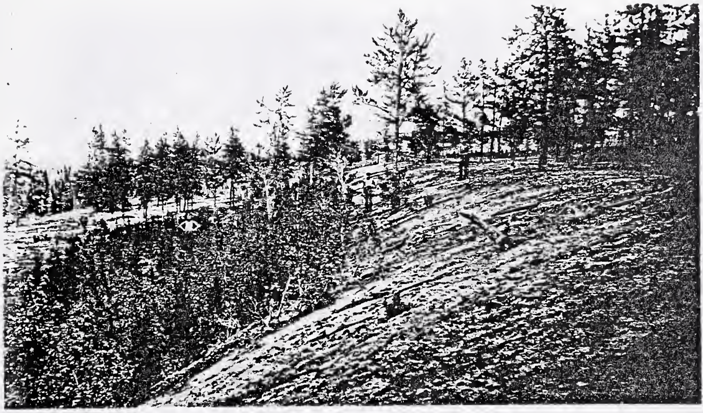


Fig.4. A relic post-glacial lake beach. One and a half miles north along trail from Fishery bay. Referred to on page 35.

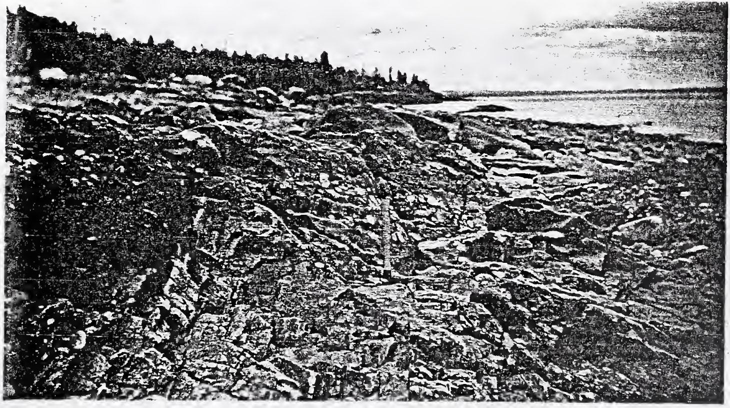


Fig.5. Athabaska conglomerate unconformably overlying tilted Tazin sediments. Referred to on page 30.

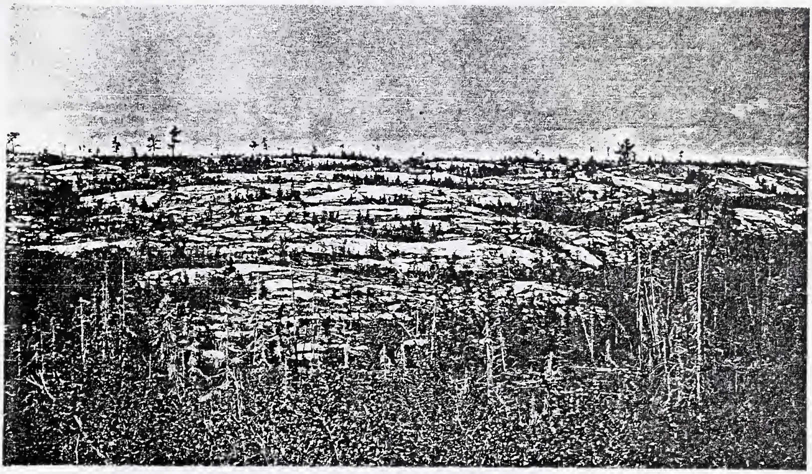


Fig.6. Metamorphosed inclusions in grey granite, northeast of Big point. Referred to on page 25.

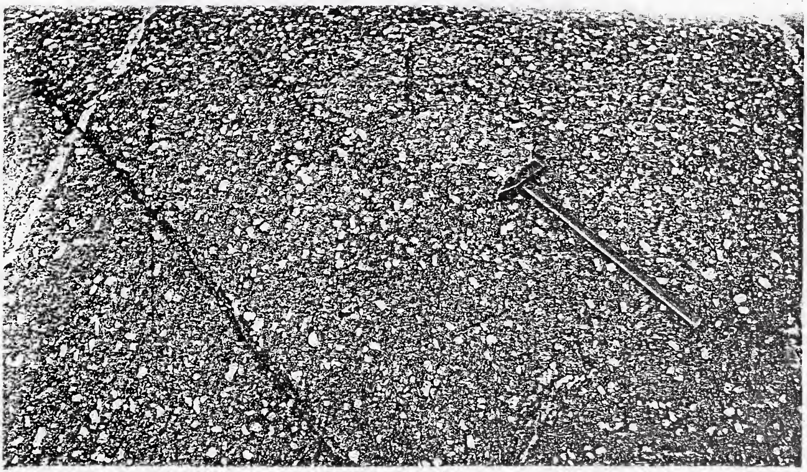


Fig.7. Porphyry gneiss which makes up the greater part of the basic inclusions in the grey granite gneisses. Referred to on page 18.

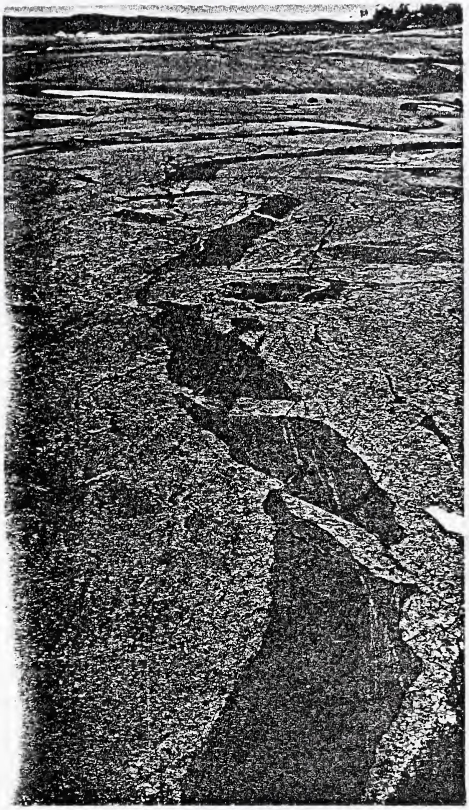


Fig.8. Metamorphosed inclusions in granite gneiss, Big point. Referred to on page 25.

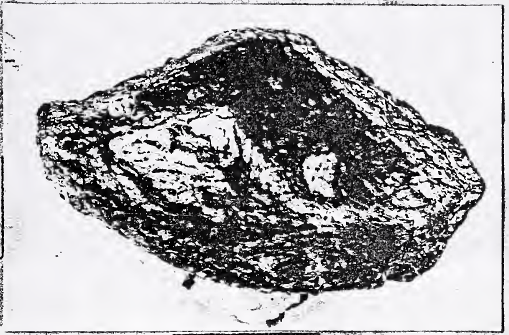


Fig. 9. Specimen G-119. BIOTITE AUGEN GNEISS.
Biotite augen gneiss from La Butte creek, showing fractured pink feldspars in green biotite.
Three-quarters actual size.

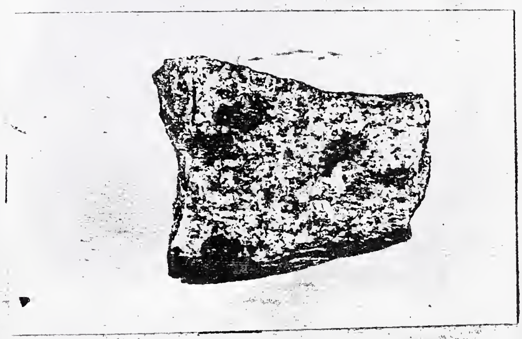


Fig.10. Specimen G-79. GRANITE.
Grey granite from south of Flett lake, showing blotches of ferromagnesian minerals.
Three-quarters actual size.

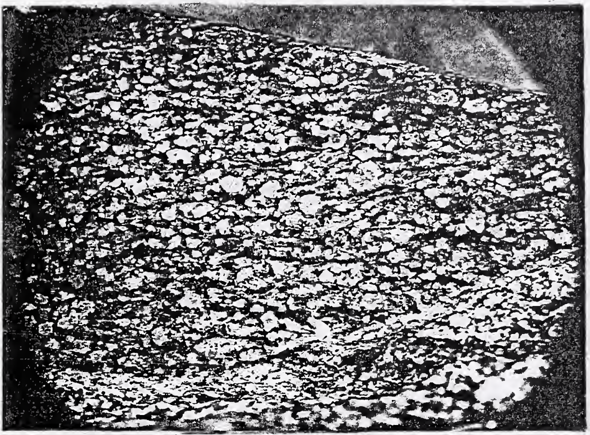


Fig.11. Specimen C-56. ARKOSE.
Photomicrograph of polished surface of the post-Tazin arkose, showing altered feldspars cemented by quartz. Magnified 2 diameters. Referred to on page 29.

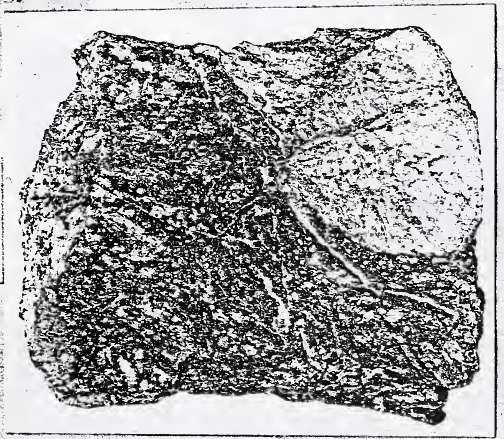


Fig.12. Specimen C-48. ARKOSIC GNEISS.
Post-Tazin arkosic gneiss showing pebbles of pink feldspar and irregular fragments of slaty material cemented by micaceous minerals. Three-quarters actual size. Referred to on page 26.

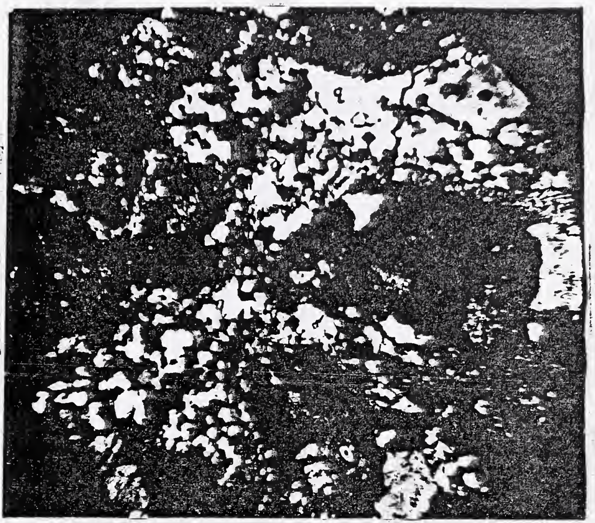


Fig.13. Thin section C-56. ARKOSE.
Photomicrograph of post-Tazin arkose, showing the cementation of kaolinized feldspar by clear granular quartz. Magnified 45 diameters, crossed nicols. q - quartz, f - feldspars.

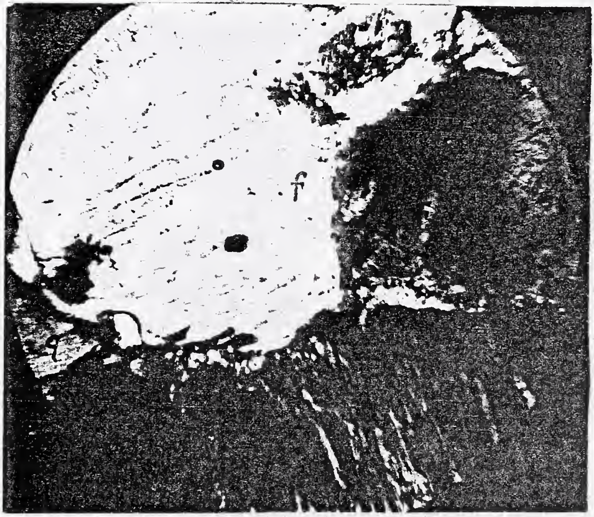


Fig.14. Thin section C-30.1. GRANITE.
Photomicrograph of granite from shore of lake No.7, showing altered feldspar and fresh, undulatory extinguishing feldspar. Magnified 75 diameters, crossed nicols.
f - feldspar, ff - altered feldspar, q - quartz.

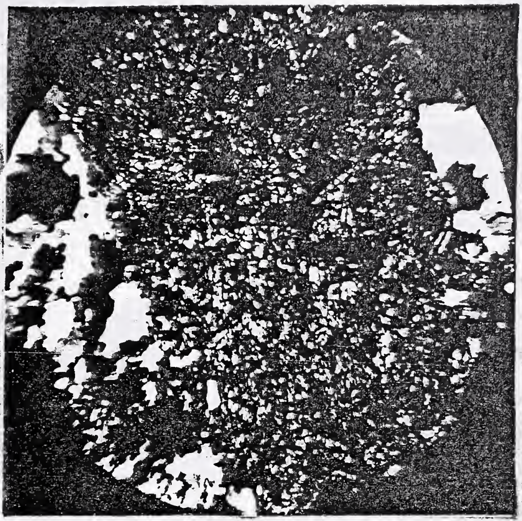


Fig.15. Thin section C-27. GRANITE GNEISS. Photomicrograph showing a 2 mm. band of well-crystallized epidote. Magnified 45 diameters, crossed nicols.

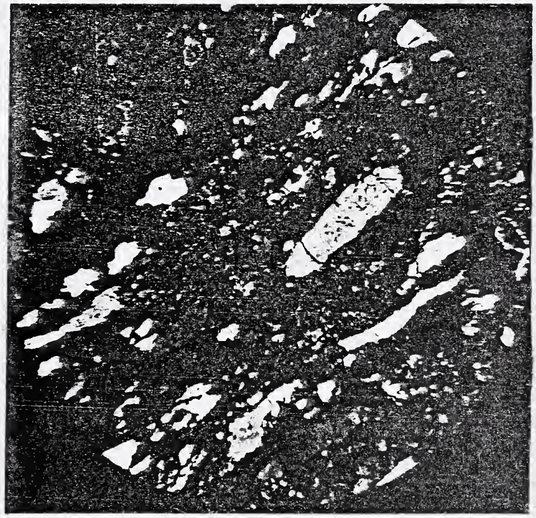


Fig.16. Thin section C-127. QUARTZ SCHIST. Photomicrograph of schist from Slave river, showing parallel introduction of later quartz (grey and white) into a schisted fragmental quartz feldspar rock. Magnified 45 diameters, crossed nicols.

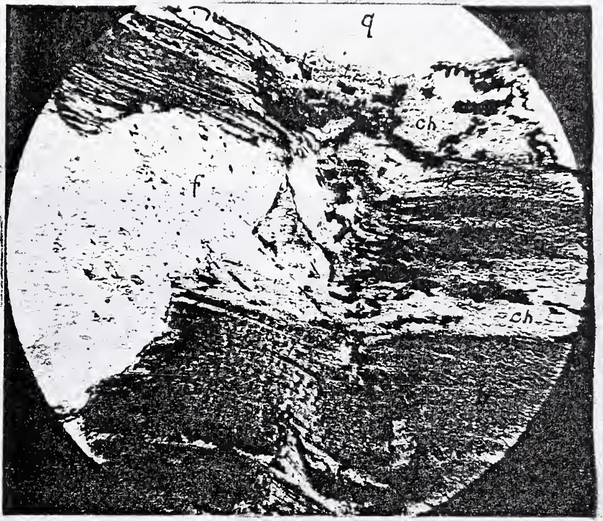


Fig.17. Thin section C-32.1. GRANITE.
Photomicrograph of granite from east end of Bryant lake, showing alteration of biotite to chlorite and iron oxide. Magnified 75 diameters, plane light.
b - biotite, ch - chlorite, f - feldspar,
fe - magnetite, q - quartz.

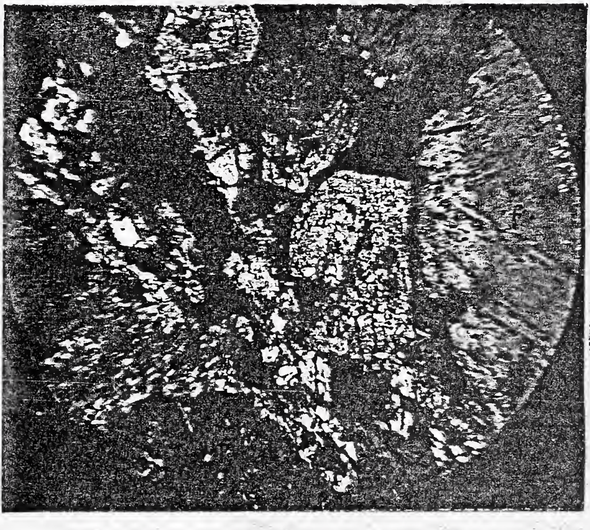


Fig.18. Thin section C-42. FELDSPAR BIOTITE GNEISS.
Photomicrograph of gneiss from point in Big bay, showing idiomorphic crystals of diopside in green biotite. Magnified 75 diameters, crossed nicols.
d - diopside, b - biotite, f - feldspar.

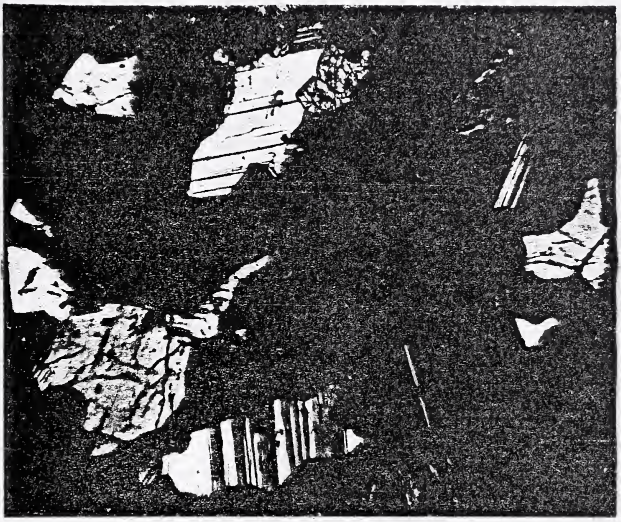
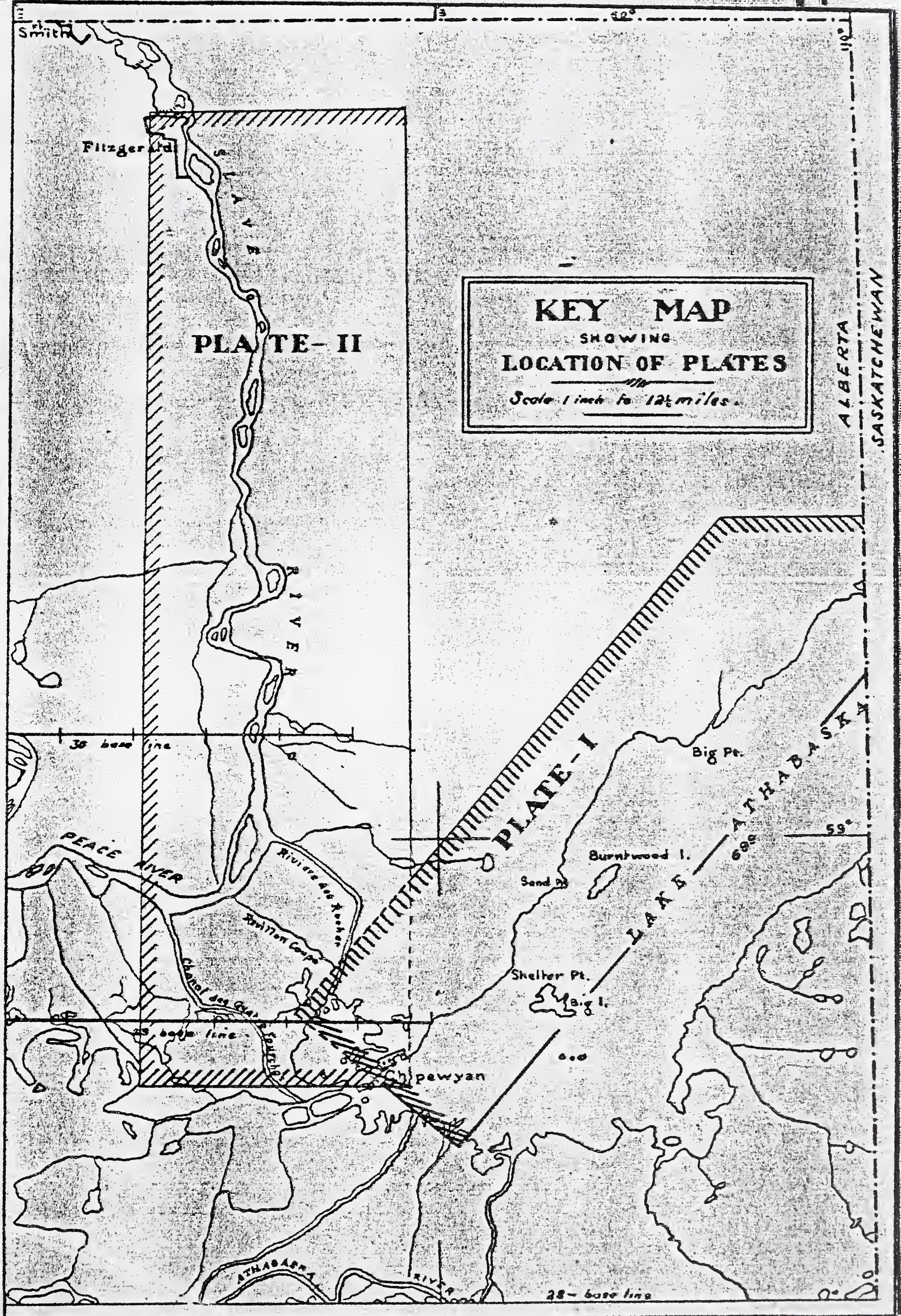
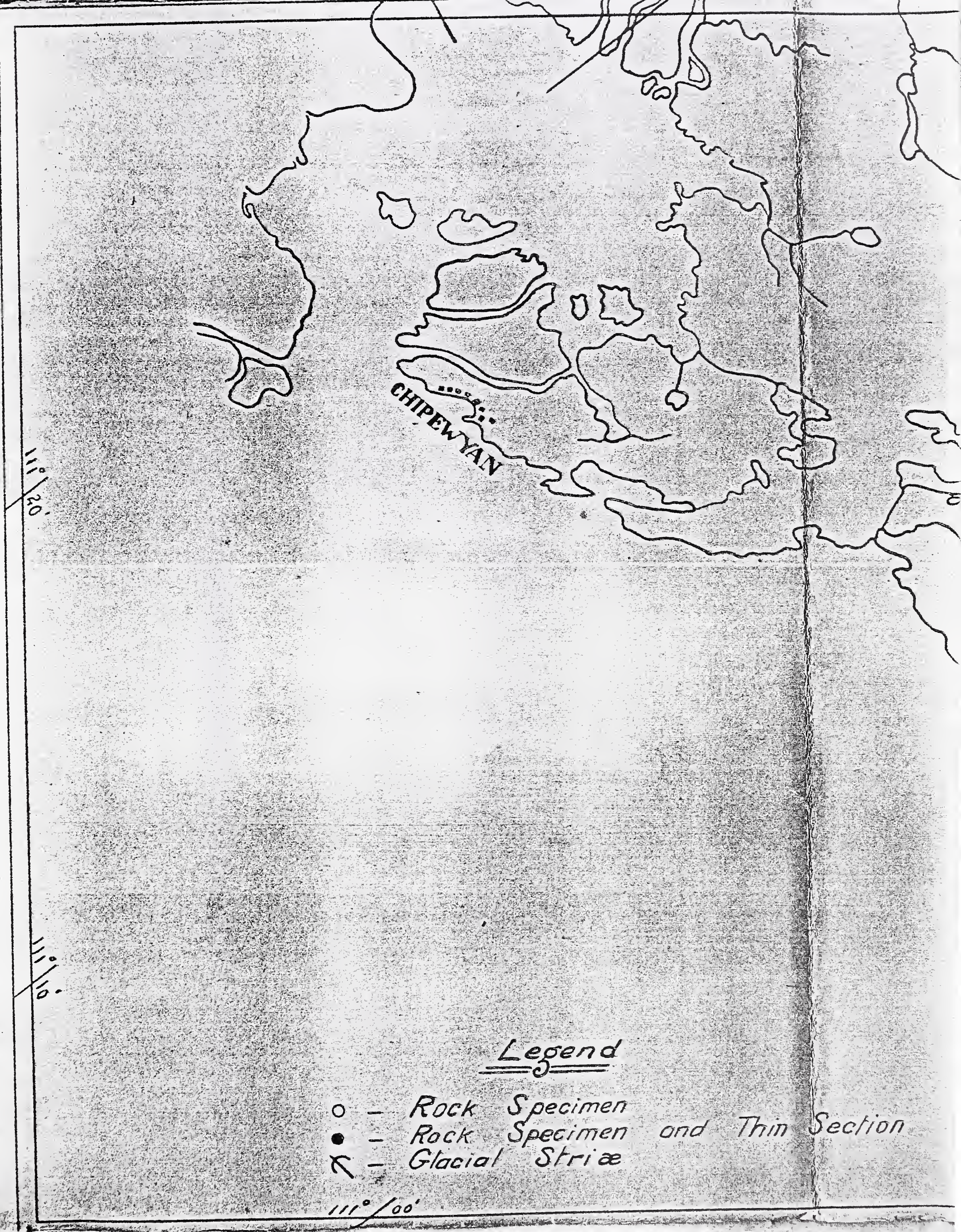
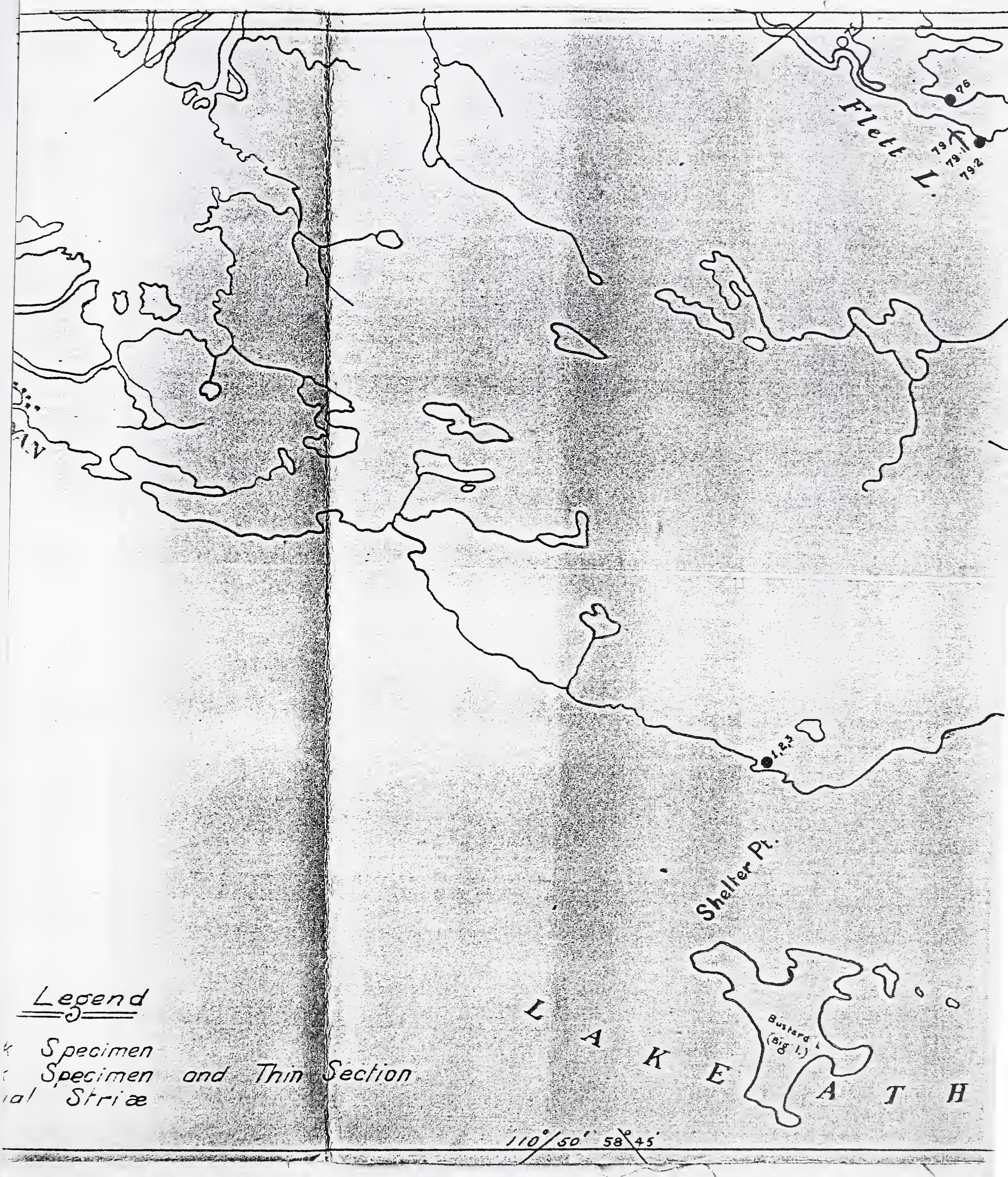


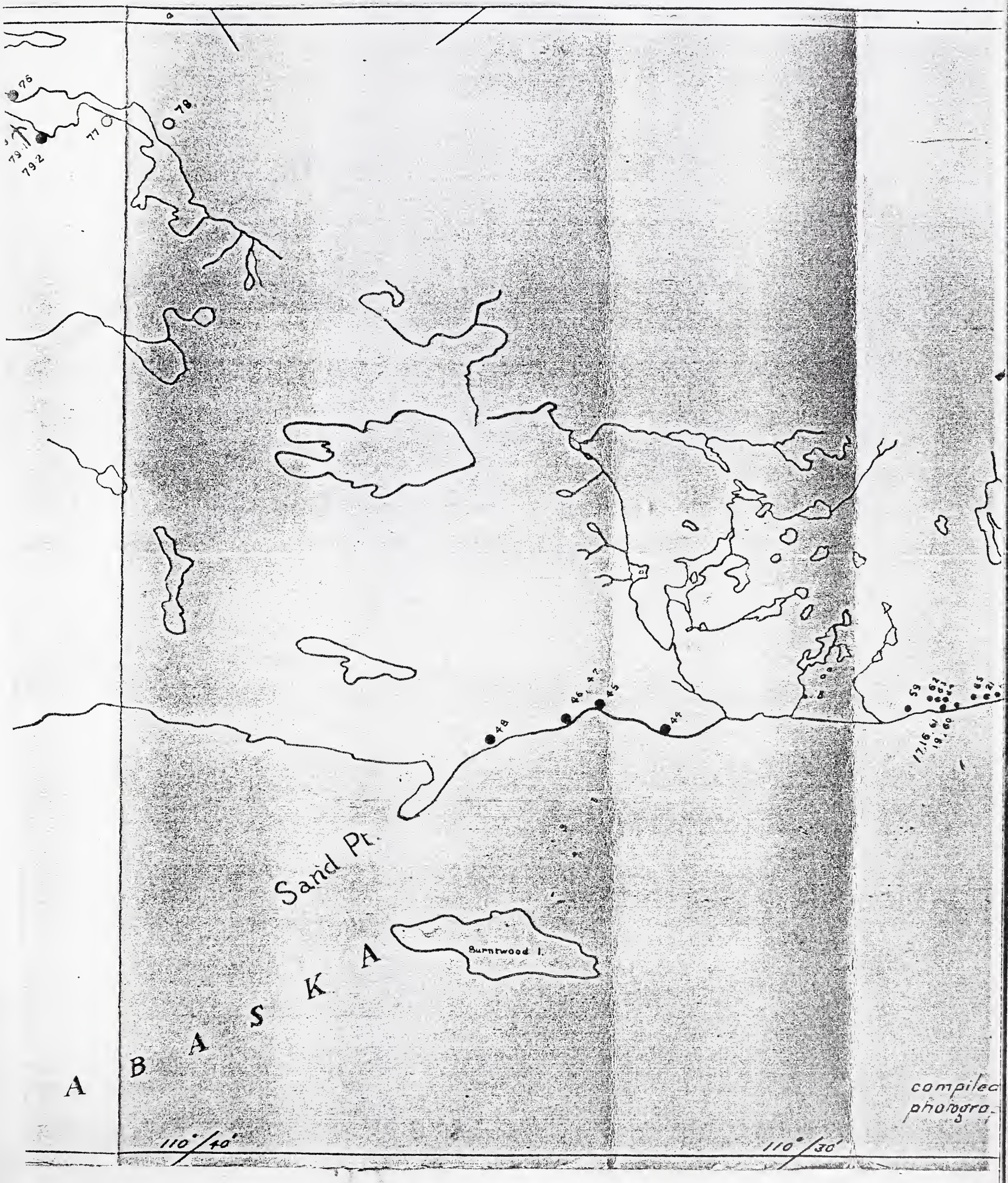
Fig.19. Thin section C-68. GABBRO.
Photomicrograph of basic inclusion in red granite, showing hornblende and labradorite.
Magnified 45 diameters, crossed nicols.
h - hornblende, f - feldspar.

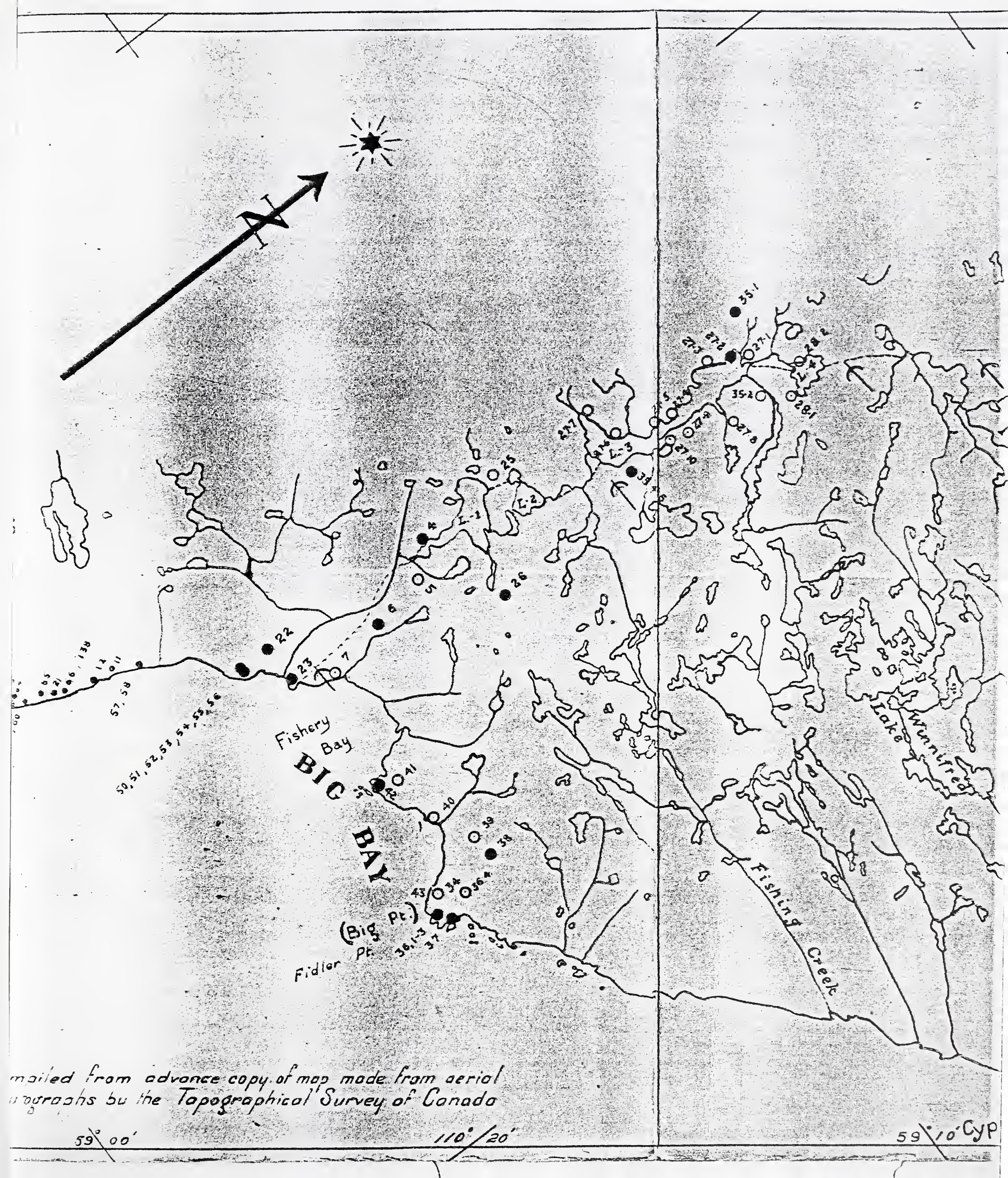


KEY MAP
SHOWING
LOCATION OF PLATES
Scale 1 inch to 12½ miles.


CHIPEWYAN
111°20'
111°10'
Legend
○ – Rock Specimen
● – Rock Specimen and Thin Section
↖ – Glacial Striæ
111°00'


Flett L.
76
79
79.1
79.2
1,2,3
Shelter Pt.
LAKE ATH
Bustard I.
(Big I.)
110° 50'
58° 45'
Legend
k Specimen
Specimen and Thin Section
ial Striæ


76
77
78
79.1
79.2
48
46
47
45
44
59
62
65
17,16, 61
19, 60
Sand Pt.
Burntwood I.
A B A S K A
compiled
photogra
110°/40'
110°/30'



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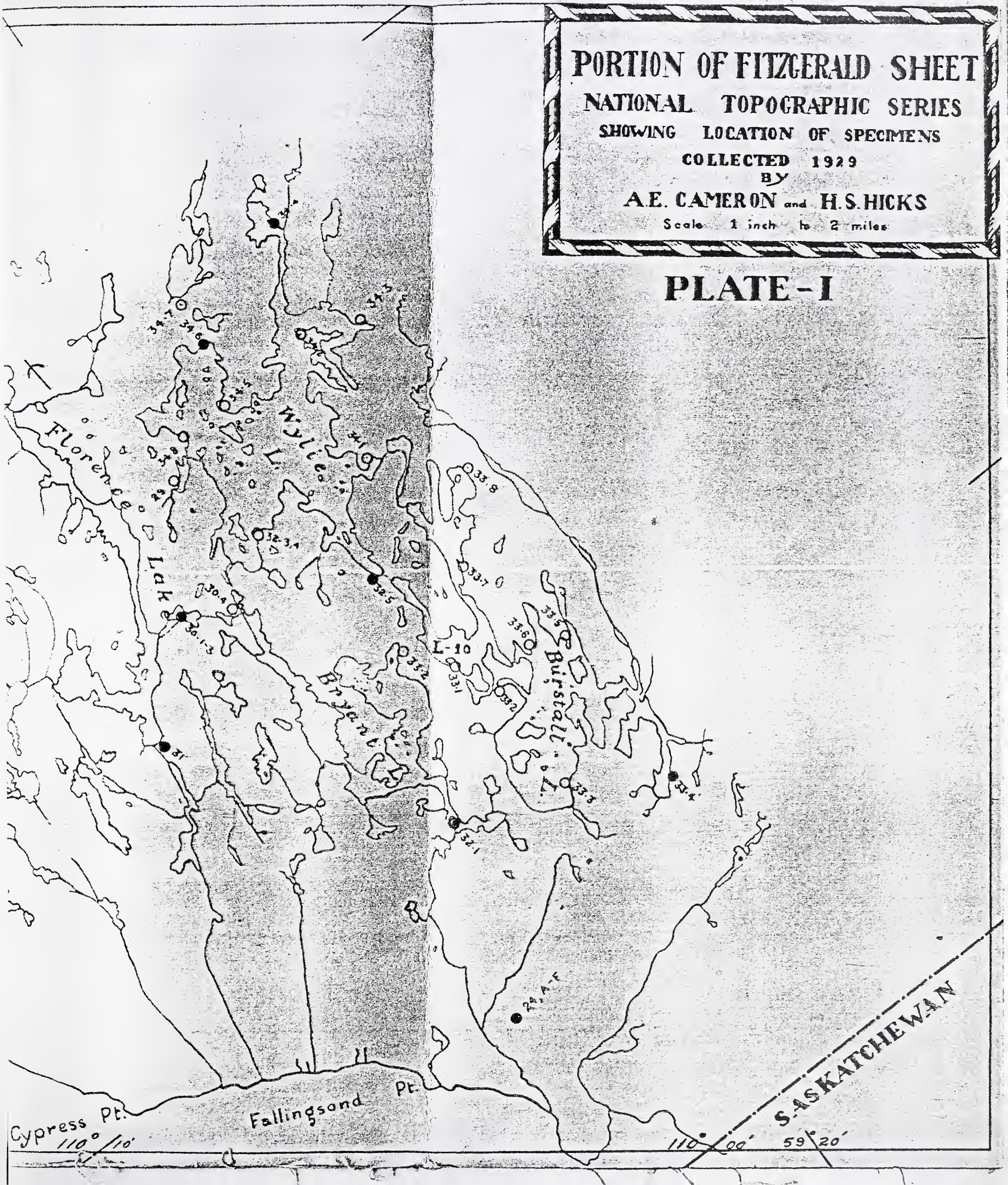
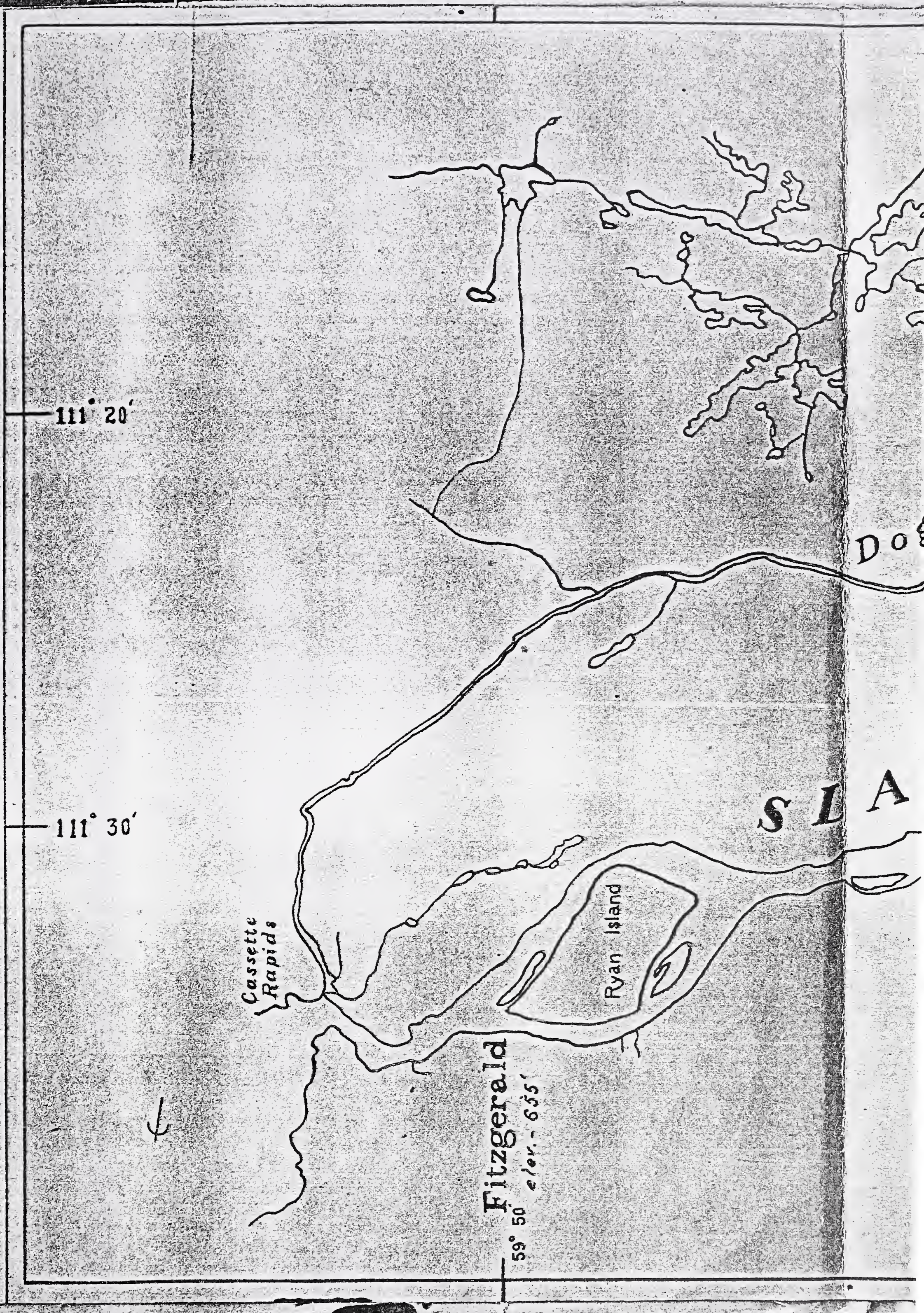
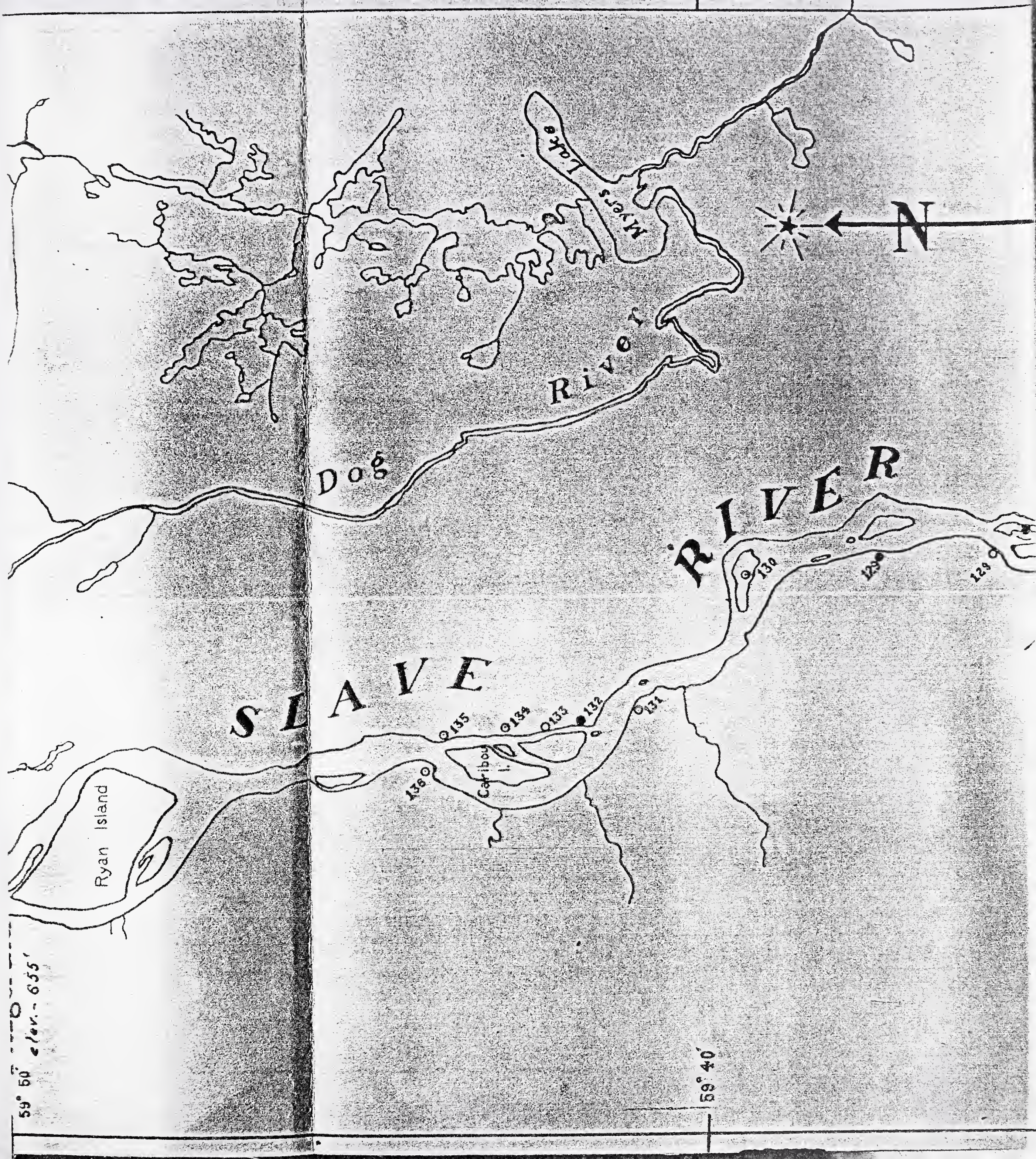
ographs by the Topographical Survey of Canada

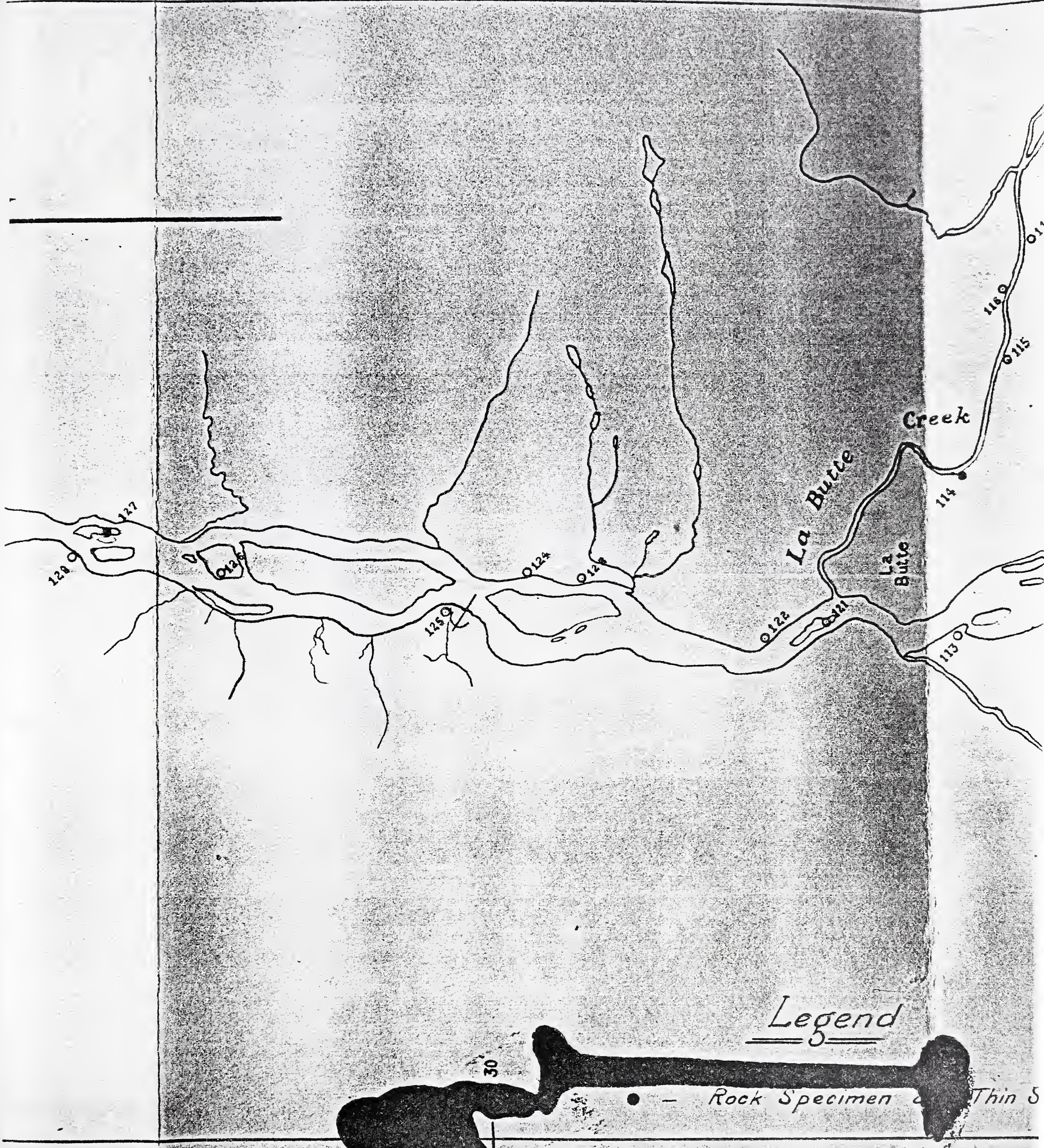


PORTION OF FITZGERALD SHEET
NATIONAL TOPOGRAPHIC SERIES
SHOWING LOCATION OF SPECIMENS
COLLECTED 1929
BY
A.E. CAMERON and H.S. HICKS
Scale 1 inch to 2 miles

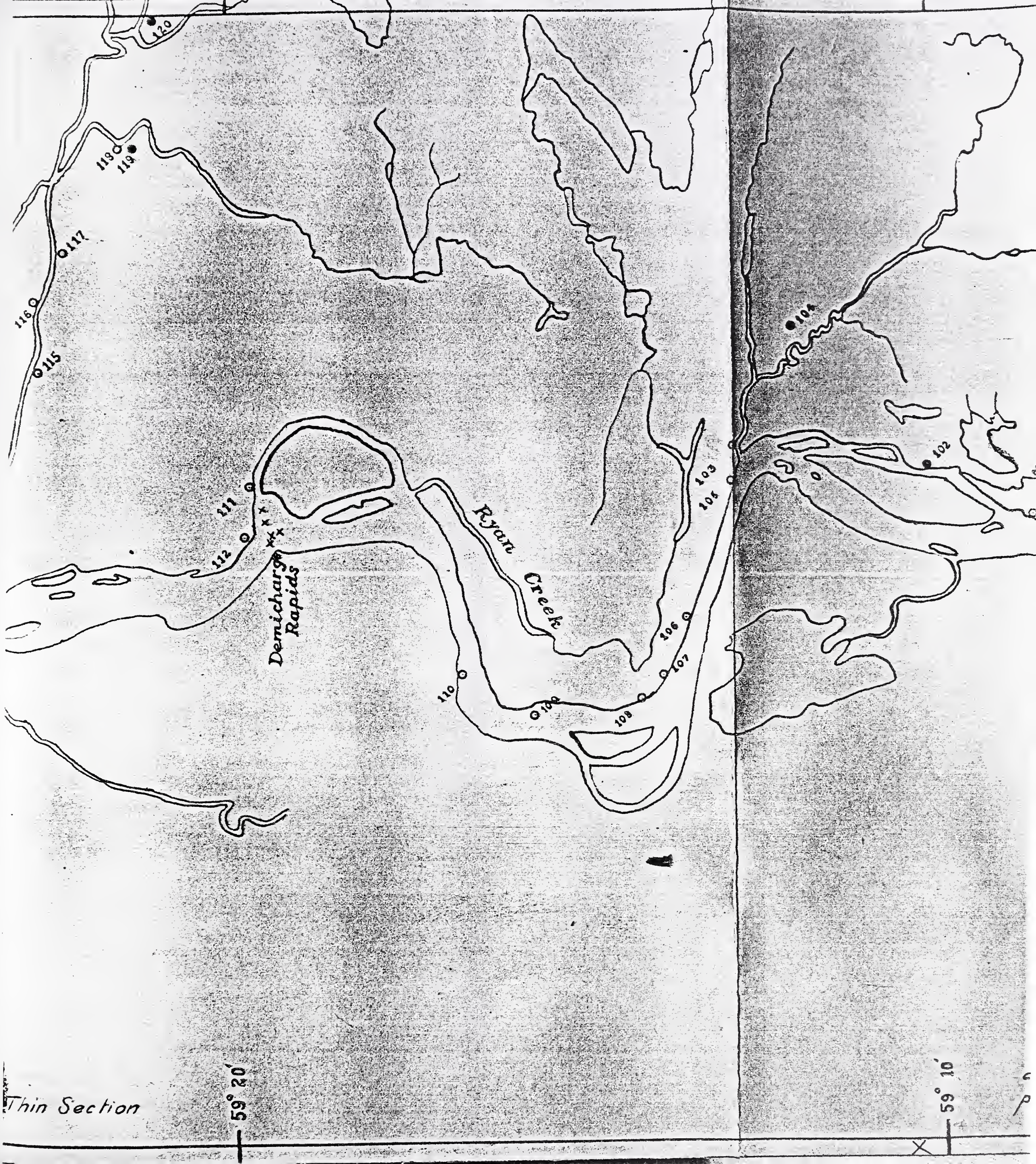
PLATE - I

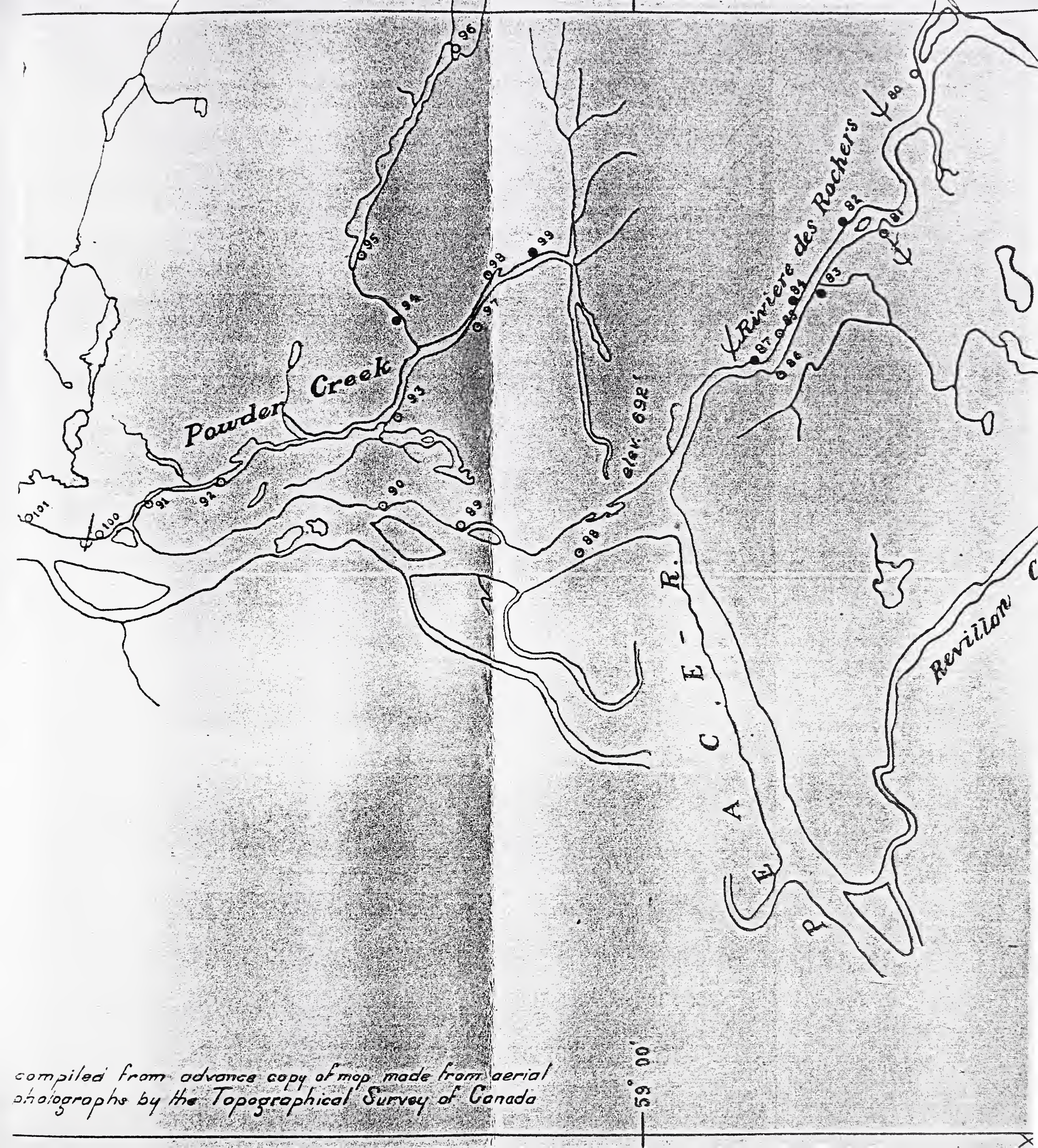

111° 20′
111° 30′
Do
SLA
Cassette Rapids
Ryan Island
Fitzgerald
59° 50′
elev. - 655′


N
Myers Lake
Dog River
SLAVE RIVER
Ryan Island
Caribou I.
128
129
130
131
132
133
134
135
136
59° 50' elev. - 655'
59° 40'



128
127
126
124
123
125
122
121
113
114
115
116
11
La Butte
Creek
La Butte
Legend
● – Rock Specimen
Thin S
30


120
118
119
117
116
115
111
112
Demicharge Rapids
Ryan Creek
103
105
104
102
106
107
108
109
110
Thin Section
59° 20'
59° 10'



compiled from advance copy of map made from aerial photographs by the Topographical Survey of Canada

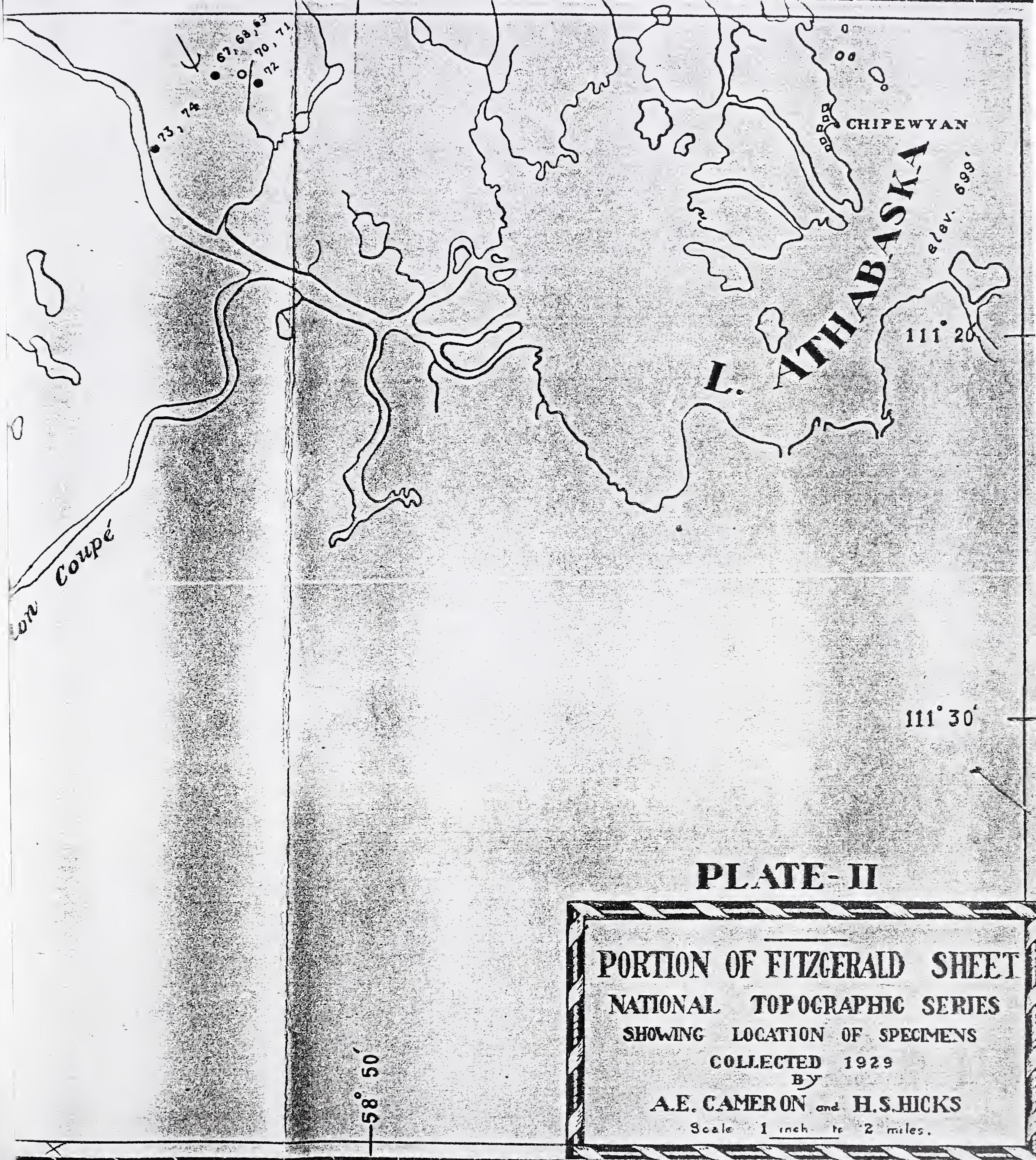


PLATE-II

PORTION OF FITZGERALD SHEET
NATIONAL TOPOGRAPHIC SERIES
SHOWING LOCATION OF SPECIMENS
COLLECTED 1929
BY
A.E. CAMERON and H.S. HICKS
Scale 1 inch to 2 miles.